Keys to Soil Taxonomy

by the

Soil Survey Staff

Agency for International Development
United States Department of Agriculture
Soil Conservation Service
Soil Management Support Services

SMSS Technical Monograph No. 19
Fifth Edition, 1992

Pocahontas Press, Inc.
Blacksburg, Virginia

Keys to Soil Taxonomy

by

Soil Survey Staff

Agency for International Development
United States Department of Agriculture
Soil Conservation Service
Soil Management Support Services

SMSS Technical Monograph No. 19
Fifth Edition, 1992

Pocahontas Press, Inc.
Blacksburg, Virginia

Keys to Soil Taxonomy, **Fifth Edition, 1992**

Published by Pocahontas Press, Inc., Blacksburg, Virginia, U.S.A.

Printed and bound in the United States of America by BookMasters, Inc., Ashland, Ohio, U.S.A.

ISBN 0-936015-39-X LC 92-28188

First Printing 1992

Keys to Soil Taxonomy, Fifth Edition

Prepared by **Pocahontas Press**
P.O. Drawer F
Blacksburg, Virginia 24063-1020
for

The Soil Management Support Services

Soil Management Support Services, U.S. Agency for International Development (AID), is a program of international technical assistance in soil survey, classification, interpretation, and use and management of soils in the intertropical countries, implemented by the Soil Conservation Service (SCS) of the United States Department of Agriculture under PASA No. AG/DSB-1129-5-79.

This publication was produced under a cooperative agreement between the Soil Management Support Services (SMSS), the Crop and Soil Environmental Sciences Department of Virginia Polytechnic Institute and State University, and Pocahontas Press of Blacksburg, Virginia, with some funding by the Agency for International Development.

The contents of this publication were provided by the Soil Conservation Service. Pocahontas Press prepared the camera-ready manuscript from text files provided by SCS, National Soil Survey Center, Lincoln, Nebraska.

To obtain additional copies:

In Developing Countries:

Ask your AID country mission, or write to:

SMSS Program Leader
Soil Conservation Service
U.S. Department of Agriculture
P.O. Box 2890
Washington, D.C. 20013

In the United States and developed countries:

Pocahontas Press, Inc.
P.O. Drawer F
Blacksburg, Virginia 24063-1020
Phone: 703-951-0467
FAX: 703-951-7340

The retail price of the book in the United States and developed countries is $20.00 in U.S. funds plus shipping charges.

Citation:
Soil Survey Staff. 1992. Keys to Soil Taxonomy, 5th edition. SMSS technical monograph No. 19. Blacksburg, Virginia: Pocahontas Press, Inc. 556 pages.

Fifth Edition, 1992

ISBN 0-936015-39-X LC 92-28188

TABLE OF CONTENTS

FOREWORD

This publication, *Keys to Soil Taxonomy*, serves two purposes. It provides the taxonomic keys necessary for the classification of soils according to Soil Taxonomy in a form that can be used easily in the field, and it also acquaints users of Soil Taxonomy with recent changes in the classification system. This volume includes all revisions of the keys that have so far been approved, replacing the original keys in *Soil Taxonomy: A Basic System of Soil Classification for Making and Interpreting Soil Surveys* (1975), the work on which this abridged version, first published in 1983, is based. We plan to continue issuing updated editions of *Keys to Soil Taxonomy* approximately every two years. After most of the current International Soil Classification Committees (ICOMs) have completed their mandates, *Soil Taxonomy* in its entirety is to be revised and republished.

This publication incorporates all amendments approved to date and published in National Soil Taxonomy Handbook (NSTH) Issues 1-16. It includes the recommendations of the International Committee on Low Activity Clays (NSTH Issue #8), the International Committee on Oxisols (NSTH Issue #11), the International Committee on Andisols (NSTH Issue #13), the International Committee on Vertisols (NSTH Issue #16), the International Committee on Aquic Moisture Regime (NSTH Issue #16), and the International Committee on Spodosols (NSTH Issue #16). Editorial changes have been made throughout this edition of *Keys to Soil Taxonomy* to make grammatical corrections and clarify the intent of the criteria.

The keys reproduced here were extracted from a computerized copy of *Soil Taxonomy* which is maintained in complete, up-to-date form.

The authors of *Keys to Soil Taxonomy* are identified as "Soil Survey Staff." This term is meant to include all the soil classifiers in the National Cooperative Soil Survey program and in the international community who have made significant contributions to the improvement of Soil Taxonomy.

RICHARD W. ARNOLD
Director, Soil Survey Division
Soil Conservation Service
1992

Chapter 1

The Soil That We Classify, and Buried Soils

THE SOIL THAT WE CLASSIFY

Soil is the collective term used in this text for the natural bodies, made up of mineral and organic materials, that cover much of the earth's surface, contain living matter and can support vegetation out of doors, and have in places been changed by human activity. The upper limit of soil is air or shallow water. Its horizontal boundaries are where it grades to deep water or to barren areas of rock or ice. The lower boundary that separates soil from the not-soil underneath is most difficult to define. Soil consists of the horizons near the earth's surface which, in contrast to the underlying rock material, have been altered by the interactions, over time, between climate, relief, parent materials, and living organisms. In the few places where it contains thin cemented horizons that are impermeable to roots, soil is considered to be as deep as the deepest cemented horizon. More commonly, soil grades at its lower boundary to hard rock or to earthy materials virtually devoid of animals, roots, or other marks of biologic activity. Thus the lower limit of soil is normally the lower limit of biologic activity, which generally coincides with the common rooting depth of native perennial plants. If, however, either biological activity or current pedogenic processes extend to depths greater than 200 cm, the lower limit of the soil that we classify is arbitrarily set at 200 cm. For certain soil management purposes, layers deeper than the lower boundary of the soil that we classify must also be described if they affect the content and movement of water and air in the soil of the root zone.

BURIED SOILS

A soil is considered to be a buried soil if it is covered with a surface mantle of new soil material that is either 50 cm or more thick, or is 30 to 50 cm thick and has a thickness that equals at least half the total thickness of the named diagnostic horizons that are preserved in the buried soil. A surface mantle of new material less than 30 cm thick is not considered in the taxonomy, but is considered in establishing a phase if it affects the use of the soil. In areas where a surface mantle is present, the soil that we classify therefore has its upper boundary either at the soil surface or less than 50 cm below the surface, depending on the thickness of its horizons.

A surface mantle of new material, as defined here, is largely unaltered. It is usually finely stratified and overlies a horizon sequence that can be clearly identified as the solum of a buried soil in at least part of each pedon. The recognition of a surface mantle should not be based only on studies of associated soils.

Chapter 2

Horizons and Properties Diagnostic for the Higher Categories: Mineral Soils[1]

MINERAL SOIL MATERIAL

Mineral soil material either:

1. Is never saturated with water for more than a few days and contains less than 20 percent (by weight) organic carbon; or

2. Is saturated with water for long periods (or artificially drained) and, excluding live roots, has an organic-carbon content (by weight) of:

   a. Less than 18 percent if the mineral fraction contains 60 percent or more clay; or

   b. Less than 12 percent if the mineral fraction contains no clay; or

   c. Less than 12 + (clay percentage multiplied by 0.1) percent if the mineral fraction contains less than 60 percent clay.

Soil material that contains more than the above amounts of organic carbon is considered to be organic soil material.

DIAGNOSTIC SURFACE HORIZONS; THE EPIPEDON

Any horizon may be at the surface of a truncated soil. The following section, however, is concerned with seven diagnostic horizons that have formed at the soil surface. A horizon that has developed at the soil surface is called an epipedon (Gr. *epi*, over, upon; and *pedon*, soil). It is a horizon in which rock structure has been destroyed and which has either been darkened by organic matter or eluviated. Such a horizon may become covered by thin alluvial or eolian deposits without losing its identity as an epipedon. The depth to which an epipedon must be buried to be considered part of a buried soil is defined above (Chapter 1).

A recent alluvial or eolian deposit that retains fine stratification, or an Ap horizon directly underlain by such stratified material, is not included in the concept of the epipedon because time has not been sufficient for soil-forming processes to erase these transient marks of

[1] Mineral soils include all soil orders in this taxonomy except Histosols.

b. 8 percent or more if the mineral fraction contains no clay; or

c. 8 + (clay percentage divided by 7.5) percent or more if the mineral fraction contains less than 60 percent clay.

Most histic epipedons consist of organic soil material as defined below. Item 2 provides for histic epipedons that are Ap horizons consisting of mineral soil material.

Melanic epipedon (Gr. *melas*, *melan-*, black)

The melanic epipedon is a thick black horizon at or near the soil surface which contains high concentrations of organic carbon, usually associated with short-range-order minerals or aluminum-humus complexes. The intense black color is attributed to the accumulation of organic matter from which "Type A" humic acids are extracted. This organic matter is thought to result from large amounts of root residues supplied by a gramineous vegetation, and can be distinguished from organic matter formed under forest vegetation by the melanic index (Honna et al., 1988).[2]

The suite of secondary minerals is usually dominated by allophane, and the soil material has a low bulk density and a high anion adsorption capacity.

The melanic epipedon has both of the following:

1. An upper boundary at, or within 30 cm of, either the mineral soil surface or the upper boundary of an organic layer with andic soil properties (defined below), whichever is shallower; and

2. In layers with a cumulative thickness of 30 cm or more within a total thickness of 40 cm, all of the following:

a. Andic soil properties throughout; and

b. A color value, moist, and chroma (Munsell designations) of 2 or less throughout, and a melanic index of 1.70 or less throughout; and

c. Six percent or more organic carbon as a weighted average, and 4 percent or more organic carbon in all layers.

Mollic epipedon (L. *mollis*, soft)

The mollic epipedon consists of mineral soil material and is at the soil surface, unless it underlies either a recent deposit that is less than 50 cm thick and has fine stratification if not plowed, or a thin layer of organic soil material. If the surface layer of organic material is

---

[2] Honna, T., S. Yamamoto, and K. Matsui. 1988. A simple procedure to determine Melanic Index. See ICOMAND Circular Letter No. 10, pp. 76-77.

and its organic-carbon content depend on the materials used for bedding.

A plaggen epipedon can be identified by several means. Commonly it contains artifacts, such as bits of brick and pottery, throughout its depth. There may be chunks of diverse materials, such as black sand and light gray sand, as large as the size held by a spade. The plaggen epipedon normally shows spade marks throughout its depth and also remnants of thin stratified beds of sand that were probably produced on the soil surface by beating rains and were later buried by spading.

Umbric epipedon (L. *umbra*, shade, hence dark)
Requirements for an umbric epipedon with regard to color, organic-carbon and phosphorus content, consistence, structure, *n* value, and thickness are the same as those for the mollic epipedon. The umbric epipedon includes those thick, dark-colored surface horizons that have a base saturation of less than 50 percent (by NH_4OAc). It should be noted that the restriction against an epipedon that is hard, very hard, or harder and massive when dry is applied only to those epipedons that become dry. If the epipedon is always moist, there is no restriction on its consistence or structure when dry. It should also be noted that some plaggen epipedons meet all these requirements but also show evidence of a gradual addition of materials during cultivation, whereas the umbric epipedon does not have the artifacts, spade marks, and raised surfaces that are characteristic of the plaggen epipedon.

DIAGNOSTIC SUBSURFACE HORIZONS

The horizons discussed in this section form below the surface of the soil, although in some areas they form directly below a layer of leaf litter. They may be exposed at the surface by truncation of the soil. Some of these horizons are generally regarded as B horizons, some are considered B horizons by many but not all pedologists, while others are generally regarded as parts of the A horizon.

Agric horizon
The agric horizon (L. *ager*, field) is an illuvial horizon which has formed under cultivation and contains significant amounts of illuvial silt, clay, and humus. After a soil has been cultivated for a long time, changes in the horizon directly below the plow layer become apparent and cannot be ignored in classifying the soil. The large pores in the plow layer and the absence of vegetation immediately after plowing permit a turbulent flow of muddy water to the base of the plow layer. Here the water can enter wormholes or fine cracks between peds, and the suspended materials are deposited as the water is withdrawn into capillary pores. The worm

channels, root channels, and surfaces of peds in the horizon underlying the plow layer become coated with a dark-colored mixture of organic matter, silt, and clay. The accumulations on the sides of wormholes become thick and can eventually fill them. If worms are scarce, the accumulations may take the form of lamellae that range in thickness from a few millimeters to about 1 cm. The lamellae and the coatings on the sides of wormholes always have a lower color value and chroma than the soil matrix.

The agric horizon can have somewhat different forms in different climates if there are differences in soil fauna. In a humid temperate climate where soils have a udic moisture regime and a mesic soil temperature regime (defined below), earthworms can become abundant. If there are earthworm holes which, including their coatings, constitute 5 percent or more (by volume) of the horizon and if the coatings are 2 mm or more thick and have a color value, moist, of 4 or less and a chroma of 2 or less, the horizon is an agric horizon. After long cultivation, the content of organic matter in the agric horizon is not likely to be high, but the carbon-nitrogen ratio is low (usually less than 8). The pH value of the agric horizon is close to neutral (6 to 6.5).

In a Mediterranean climate where soils have a xeric soil moisture regime (defined below), earthworms are less common and the illuvial materials accumulate as lamellae directly below the Ap horizon. If these lamellae are 5 mm or more thick, have a color value, moist, of 4 or less and a chroma of 2 or less, and constitute 5 percent or more (by volume) of a horizon 10 cm or more thick, this horizon is an agric horizon.

Albic horizon

The albic (L. *albus*, white) horizon is an eluvial horizon 1.0 cm or more thick which contains 85 percent or more (by volume) albic materials (defined below). It usually occurs below an A horizon but may be at the mineral soil surface. Under the albic horizon there is usually an argillic, cambic, kandic, natric, or spodic horizon or a fragipan (defined below). The albic horizon may lie between a spodic horizon and either a fragipan or an argillic horizon; or it may be between an argillic or a kandic horizon and a fragipan. It may lie between a mollic epipedon and an argillic or natric horizon, or between a cambic horizon and an argillic, kandic, or natric horizon or a fragipan. The albic horizon may separate horizons which, if together, would meet the requirements for a mollic epipedon. It may separate lamellae that together meet the requirements for an argillic horizon; these lamellae are not considered to be part of the albic horizon.

In some soils the horizon underlying the albic horizon is too sandy or too weakly developed to have the levels of accumulation required for an argillic, a kandic, a natric, or a spodic horizon. Some soils have, directly below the albic horizon, either a lithic or paralithic contact, or another relatively impervious layer that produces a perched water table with stagnant or moving water.

Argillic horizon

An argillic horizon is an illuvial horizon which contains significant accumulations of illuviated layer-lattice silicate clays. It must have formed below an eluvial horizon but may be found at the surface of a partially truncated soil. The following characteristics are used for its identification:

1. If there is a lithologic discontinuity between the overlying eluvial horizon and the argillic horizon or if it is overlain only by a plow layer, clay films are required only in some part of the argillic horizon, either in some fine pores or, if peds are present, on some vertical and horizontal surfaces of peds. Either some part of the horizon is shown in thin section to have 1 percent or more oriented clay bodies, or the ratio of fine clay to total clay in the argillic horizon is higher than in the overlying or the underlying horizon.

2. If an eluvial horizon remains and there is no lithologic discontinuity between it and the underlying argillic horizon, the argillic horizon contains, within 30 cm of its upper boundary, higher percentages of total clay and fine clay than the eluvial horizon, as follows:

a. If any part of the overlying eluvial horizon has less than 15 percent total clay in its fine-earth fraction, the total clay content in the argillic horizon is 3 percent or more (absolute) higher than in the eluvial horizon (e.g., 13 percent versus 10 percent). The ratio of fine clay to total clay in the argillic horizon is normally one third or more higher than in the overlying eluvial or in the underlying horizon.

b. If the overlying eluvial horizon has 15 to 40 percent total clay in its fine-earth fraction, the total clay content in the argillic horizon is 20 percent or more (relative) higher than in the eluvial horizon (e.g., 24 percent versus 20 percent). The ratio of fine clay to total clay in the argillic horizon is normally one third or more higher than in the eluvial horizon.

c. If the eluvial horizon has 40 to 60 percent total clay in the fine-earth fraction, the total clay content in the argillic horizon is 8 percent or more (absolute) higher than in the eluvial horizon (e.g., 50 percent versus 42 percent).

d. If the eluvial horizon has 60 percent or more total clay in the fine-earth fraction, the fine-clay content in the argillic horizon should be 8 percent or more (absolute) higher than that of the eluvial horizon.

3. The thickness of the argillic horizon is one tenth or more the total thickness of all overlying horizons (in a soil that is not truncated and has no lithologic discontinuity between the eluvial horizon and the underlying argillic horizon), and one of the following:

a. 7.5 cm or more if the horizon is loamy or clayey; or

b. 15 cm or more if the horizon is sand or loamy sand; or

c. If the horizon is composed entirely of lamellae, 15 cm or more combined thickness of lamellae that are 1 cm or more thick.

4. In structureless soils, the argillic horizon has oriented clay lining some pores and bridging the sand grains.

5. If peds are present, the argillic horizon has one of the following:

a. Either clay films on some vertical and horizontal surfaces of peds and in the fine pores, or oriented clay in 1 percent or more of the cross section; or

b. A broken or irregular upper boundary and some clay films in the lowest part of the horizon; or

c. If the eluvial horizon has 40 percent or more clay, and if the argillic horizon is clayey and the clay is kaolinitic, some clay films on peds and in pores within the lower part of the argillic horizon if it has blocky or prismatic structure; or

d. No clay films if the argillic horizon is clayey with 2:1 lattice clays, and if either the overlying horizon has uncoated grains of sand or silt and the argillic horizon shows evidence of pressure caused by swelling (e.g., occasional slickensides or wavy horizon boundaries), or if the ratio of fine clay to total clay in the argillic horizon is one third or more higher than in the overlying or underlying horizon, or if the fine-clay content in the argillic horizon is 8 percent or more (absolute) higher than in the eluvial horizon.

Calcic horizon

The calcic horizon is a horizon in which calcium carbonate, or calcium and magnesium carbonate, has accumulated. It may occur within the C horizon or within various other horizons such as a mollic epipedon, an argillic or a natric horizon, or a duripan.

The calcic horizon is 15 cm or more thick and meets one of the following requirements:

firm; if it is near field capacity, the matrix is brittle. This brittle matrix constitutes 60 percent or more (by volume) of one or more subhorizons of the fragipan.

5. The brittleness in parts of the fragipan is well enough expressed so that there are virtually no fine feeder roots in this brittle matrix, which has mean horizontal dimensions of 10 cm or more. The surrounding bleached vertical streaks may contain few to many fine feeder roots and some tap roots of trees.

6. The fine-earth fraction of a fragipan has a texture finer than fine sand and generally contains less than 35 percent clay (in most soils considerably less); it is generally loamy (silt loam, loam, or sandy loam).

7. A fist-sized, air-dried fragment of a fragipan slakes or fractures when placed in water.

Glossic horizon

The glossic (Gr. *glossa*, tongue) horizon is 5 cm or more thick and consists of:

1. An eluvial part, i.e., albic materials (defined below), which constitute 15 to 85 percent (by volume) of the glossic horizon; and

2. An illuvial part, i.e., remnants of an argillic, a kandic, or a natric horizon (defined below).

The glossic horizon develops as a result of the degradation of an argillic, a kandic, or a natric horizon, from which clay and free iron oxides are removed. This process of eluviation gradually progresses from the exteriors of peds to their interiors. In early stages of the development, the peds of the remnant argillic, kandic, or natric horizon still form structural units that extend throughout the glossic horizon, constituting close to 85 percent of its volume. In later stages, some of these structural units no longer extend throughout the horizon, and in the most advanced stages of the degradation process remnant peds constitute little more than 15 percent (by volume) of the glossic horizon and are completely surrounded by albic materials. The boundary between the illuvial and eluvial parts of the glossic horizon may be either abrupt or clear, and either irregular or broken.

A glossic horizon usually occurs between an overlying albic horizon and an underlying argillic, kandic, or natric horizon or fragipan. It can lie between an argillic, cambic, or kandic horizon and a fragipan. In the early stages of the degradation process described above, a glossic horizon can be within an argillic, kandic, or natric horizon, or within a fragipan if the fragipan shows evidence of the degradation of an argillic horizon. An albic horizon may be below, or between subhorizons of, the glossic horizon.

Argillic horizons consisting of lamellae and intervening albic materials are not within the concept of the glossic horizon.

Gypsic horizon

The gypsic horizon is a horizon of enrichment with secondary sulfates that is 15 cm or more thick and has the following properties:

1. It is noncemented (an air-dried fragment slakes in water); and

2. Its gypsum content is 5 percent or more (absolute) higher than that of an underlying 1C horizon; and

3. The product of its thickness in centimeters multiplied by its gypsum percentage is 150 or more.

Thus, a horizon 30 cm thick that has 5 percent gypsum qualifies as a gypsic horizon if gypsum is absent in an underlying 1C horizon. A layer 30 cm thick that has 6 percent gypsum qualifies if the gypsum content of the underlying horizon is no more than 1 percent. The gypsum percentage can be calculated by multiplying the milliequivalents of gypsum per 100 g soil by the milliequivalent weight of $CaSO_4{\cdot}2H_2O$, which is 0.086.

Kandic horizon[5]

The kandic horizon:

1. Is a vertically continuous subsurface horizon that underlies a coarser-textured surface horizon. The minimum thickness of the surface horizon is 18 cm after mixing, or 5 cm if the textural transition to the kandic horizon is abrupt and there is no lithic, paralithic, or petroferric contact (defined below) within 50 cm of the mineral soil surface.

2. Has its upper boundary:

   a. At the point where the clay percentage in the fine-earth fraction, increasing with depth within a vertical distance of 15 cm or less, is either

      (1) 4 percent or more (absolute) higher than in the surface horizon if that horizon has less than 20 percent total clay in the fine-earth fraction; or

      (2) 20 percent or more (relative) higher than in the surface horizon if that horizon has 20 to 40 percent total clay in the fine-earth fraction; or

      (3) 8 percent or more (absolute) higher than in the surface horizon if that horizon has

---

[5] The kandic horizon and the *kandi* and *kanhapli* great groups of soils represent the work of the International Committee on the Classification of Low Activity Clays (ICOMLAC), chaired by Dr. Frank R. Moormann.

1. Either

 a. Columns, or less commonly, prisms in some (usually the upper) part, which may break to blocks; or

 b. Rarely, blocky structure, and tongues of an eluvial horizon which contain uncoated silt or sand grains and extend more than 2.5 cm into the horizon; and

2. Either

 a. An exchangeable sodium percentage (ESP) of 15 percent or more (or a sodium adsorption ratio, SAR, of 13 or more) in one or more subhorizons within 40 cm of its upper boundary; or

 b. More exchangeable magnesium plus sodium than calcium plus exchange acidity (at pH 8.2) in one or more subhorizons within 40 cm of its upper boundary, if the ESP is 15 or more (or the SAR is 13 or more) in one or more horizons within 200 cm of the mineral soil surface.

Oxic horizon

The oxic horizon is a mineral subsurface horizon of sandy loam or a finer particle size with low cation exchange capacity and low weatherable-mineral content. Its upper boundary is either 18 cm below the mineral soil surface or at the lower boundary of an Ap horizon, whichever is deeper, or at a greater depth where mineralogical and charge characteristics meet the requirements for the oxic horizon. Any increase in clay content at the upper boundary must be diffuse. The lower boundary of the oxic horizon is also defined by its mineralogical and charge requirements and may, in addition, be defined by the presence of saprolite with rock structure.

The oxic horizon does not have andic soil properties (defined below), and has all the following characteristics:

1. A thickness of 30 cm or more; and

2. A particle size of sandy loam or finer in the fine-earth fraction; and

3. Less than 10 percent weatherable minerals in the 50-to-200-micron fraction; and

4. Rock structure in less than 5 percent of its volume, or sesquioxide coatings on lithorelicts containing weatherable minerals; and

5. A diffuse upper particle-size boundary, i.e., within a vertical distance of 15 cm, a clay increase with depth of:

 a. Less than 4 percent (absolute) in its fine-earth fraction if that of the surface horizon contains less than 20 percent clay; or

b. Less than 20 percent (relative) in its fine-earth fraction if that of the surface horizon contains 20 to 40 percent clay; or

c. Less than 8 percent (absolute) in its fine-earth fraction if that of the surface horizon contains 40 percent or more clay); and

6. A CEC of 16 cmol(+) or less per kg clay[7] (by 1N NH_4OAc pH 7) and an ECEC of 12 cmol(+) or less per kg clay (sum of bases extracted with 1N NH_4OAc pH 7, plus 1N-KCl-extractable Al).

Petrocalcic horizon

The petrocalcic horizon is indurated or cemented throughout each pedon by calcium carbonate or, less commonly, by calcium and magnesium carbonate, with or without accessory silica, to such a degree that dry fragments do not slake in water. If soaked in acid, cementation of the petrocalcic horizon is destroyed in half or more of its lateral extent in each pedon. The horizon is massive or platy, very hard, extremely hard, or harder (cannot be penetrated by spade or auger) when dry, and very firm, extremely firm, or firmer when moist. Its noncapillary pores are filled, and it is a barrier to roots. Its hydraulic conductivity is moderately low to very low. A laminar capping commonly is present but is not required.

The petrocalcic horizon is typically 10 cm or more thick. A minimum thickness of 2.5 cm is required if it is laminar and rests on bedrock, and if the product of its thickness in centimeters multiplied by its percentage of $CaCO_3$ equivalent is 200 or more.

Petrogypsic horizon

The petrogypsic horizon is a horizon 10 cm or more thick which is so strongly cemented with gypsum that dry fragments do not slake in water and roots cannot enter. Its gypsum content commonly is far greater than the minimum requirements for a gypsic horizon, usually 60 percent or more. Petrogypsic horizons are restricted to arid climates and to parent materials that are rich in gypsum. They are rare in the United States but are common in parts of Africa and Asia.

Placic horizon

The placic horizon (Gr. *plax*, *plak-*, flat stone; meaning a thin cemented pan) is a thin, black to dark reddish pan that is cemented either by iron, or iron and manganese, or an iron-organic-matter complex. It is generally between 2 and 10 mm thick, but may be as thin as 1 mm or, in spots, up to 40 mm thick. It is often associated

---

[7] The percentage of clay is either measured by the pipette method, or estimated to be 3 times (percent water retained at 1500 kPa tension minus percent organic carbon), whichever value is higher, but no more than 100.

with stratification in parent materials. The placic horizon is in the solum, commonly within 50 cm of the mineral soil surface, and roughly parallel with it. It has a pronounced wavy or even convolute form. Normally it occurs as a single pan rather than as multiple sheets (one underlying another), but it may be bifurcated. It is a barrier to water and roots.

If cemented by iron, the pan is strong brown to dark reddish brown; if cemented by iron and manganese or by iron-organic-matter complexes, it is black or reddish black. A single pan may contain two or more layers that are cemented by different agents; commonly iron-organic-matter complexes are found in the upper part of the pan.

Unless its thickness is minimal, identification of a placic horizon is seldom difficult because the hard, brittle pan differs so much from the material in which it occurs and is so close to the mineral soil surface. Analyses of placic horizons show that they contain between 1 and more than 10 percent organic carbon. The presence of organic carbon and the shape and position of the placic horizon distinguish it from the ironstone sheets that may form where water hangs, or moves laterally, at a lithologic discontinuity.

Salic horizon

A salic horizon is a horizon 15 cm or more thick containing a secondary enrichment of salts which, in cold water, are more soluble than gypsum. It has a salt content of 2 percent or more (by weight) throughout, and the product of its thickness (in centimeters) multiplied by its salt percentage (by weight) is 60 or more. Thus, a horizon 20 cm thick must contain 3 percent salt to qualify as a salic horizon, while a horizon 30 cm thick requires 2 percent.

Sombric horizon

The sombric horizon (Sp *sombra* shade, hence dark) is a subsurface horizon of mineral soils which has formed under free drainage. It contains illuvial humus that is neither associated with aluminum, as is the humus in the spodic horizon, nor dispersed by sodium, as is common in the natric horizon. Consequently the sombric horizon does not have the high cation-exchange capacity in its clay that characterizes a spodic horizon, and it does not have the high base saturation of a natric horizon. It does not underlie an albic horizon.

Sombric horizons are thought to be restricted to the cool, moist soils of high plateaus and mountains in tropical or subtropical regions. Because of strong leaching, their base saturation is low (less than 50 percent by NH_4OAc).

The sombric horizon has a lower color value or chroma, or both, than the overlying horizon and commonly contains more organic matter. It may have formed in an argillic, a cambic, or an oxic horizon. If peds are present, the dark colors are most pronounced on surfaces of peds.

In the field, a sombric horizon is easily mistaken for a buried A horizon. It can be distinguished from some buried epipedons by lateral tracing. In thin sections, the organic matter of a sombric horizon appears more concentrated on peds and in pores rather than uniformly dispersed through the matrix.

Spodic horizon

The spodic horizon is an illuvial layer that is 2.5 cm or more thick, is not part of an Ap horizon, and contains 85 percent or more spodic materials (defined below).

Spodic materials contain illuvial active amorphous materials composed of organic matter and aluminum, with or without iron. The term "active" is used here to describe materials that have a high pH-dependent charge, a large surface area, and high water retention. In uncultivated soils the spodic horizon normally lies below an albic horizon; less commonly, it is either under an ochric epipedon that does not meet the color requirements of an albic horizon, or in or under an umbric epipedon. In some soils the spodic horizon is at the surface of the mineral soil directly below a thin O horizon. In cultivated soils it generally occurs directly below the Ap horizon.

Sulfuric horizon

The sulfuric (L. *sulfur*) horizon is 15 cm or more thick and is composed of either mineral or organic soil material that has a pH value of 3.5 or less (1:1 by weight in water, or in a minimum of water to permit measurement) and shows evidence that the low pH value is caused by sulfuric acid. The evidence is one or more of the following:

1. Jarosite concentrations, or

2. Directly underlying sulfidic materials (defined below), or

3. 0.05 percent or more water-soluble sulfate.

A sulfuric horizon forms as a result of drainage, most commonly artificial, and oxidation of sulfide-rich mineral or organic soil materials. Such a horizon is highly toxic to most plants. It may also form in places where sulfidic materials have been exposed as a result of surface mining, road construction, dredging, or other earth-moving operations.

c. A chroma that is controlled by the color of uncoated grains of silt or sand, a hue of 5YR or redder, and color values listed in 1.a or 1.b above.

Relatively unaltered layers of light-colored sand, volcanic ash, or other materials deposited by wind or water are not considered albic materials, although they may have the same color and apparent morphology. These deposits are parent materials which have not had clay and/or free iron removed and do not overlie an illuvial horizon or other soil horizon except a buried soil. Light-colored krotovina or filled root channels should only be considered albic materials if they have no fine stratifications or lamellae, if any sealing along krotovina walls has been destroyed, and if these intrusions have, after deposition, been leached of free iron oxides and/or clay.

Andic soil properties

To be recognized as having andic soil properties, soil materials must contain less than 25 percent (by weight) organic carbon and meet one or both of the following requirements:

1. In the fine-earth fraction, all of the following:

a. Aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 2.0 percent or more, and

b. A bulk density, measured at 33 kPa water retention, of 0.90 g/cm^3 or less, and

c. A phosphate retention[8] of 85 percent or more; or

2. In the fine-earth fraction, a phosphate retention of 25 percent or more, 30 percent or more particles of 0.02 to 2.0 mm, and one of the following:

a. Aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more and, in the 0.02-to-2.0-mm fraction, 30 percent or more volcanic glass; or

b. Aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 2.0 or more and, in the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass; or

c. Aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling between 0.40 and 2.0 and, in the 0.02-to-2.0-mm fraction, enough volcanic glass so that the glass percentage, when plotted against the value obtained by adding aluminum plus 1/2 iron percentages in the fine-earth fraction, falls within the shaded area of Figure 1.

---

[8] Blakemore, L.C., P.L. Searle, and B.K. Daly. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. pp 44-45.

Figure 1

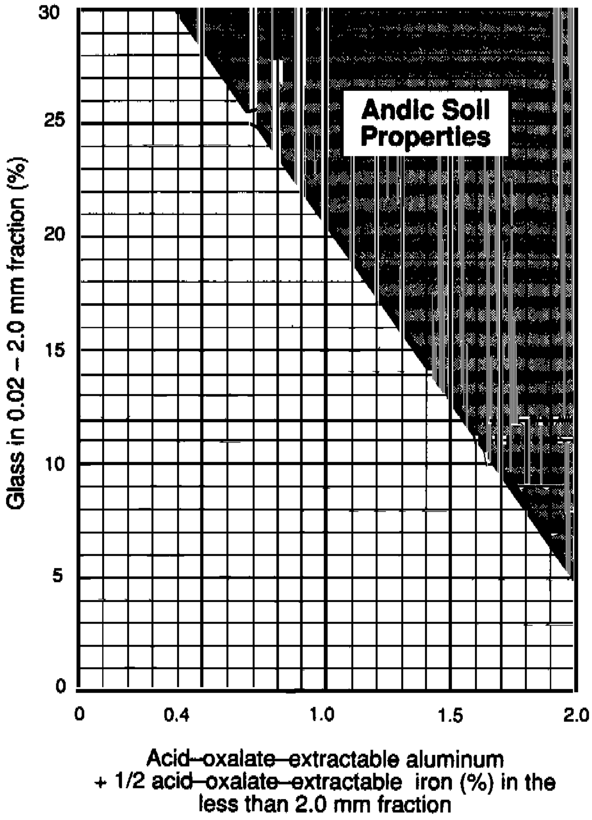

Figure 1 — *Soils that plot in the shaded area have Andic soil properties if the less than 2.0 mm fraction has phosphate retention of more than 25 percent and the 0.02 to 2.0 mm fraction is at least 30 percent of the less than 2.0 mm fraction.*

Aquic conditions[9]

Soils with aquic (L. *aqua*, water) conditions are those which currently experience continuous or periodic saturation and reduction. The presence of these conditions is indicated by *redoximorphic features* (defined below) and can be verified, except in artificially drained soils,[10] by measuring saturation and reduction.

---

[9] The term *aquic conditions* was introduced, and other changes were made throughout Soil Taxonomy, in 1992 as a result of recommendations submitted to SCS by the International Committee on Aquic Moisture Regime (ICOMAQ), which was established in 1982 and chaired initially by Frank Moormann, then by Johan Bouma (since 1985).

[10] Artificial drainage is defined here as removal of free water from soils (by surface mounding, ditches, or subsurface tiles) to the extent that watertable levels are changed significantly in connection with specific types of land use. In the keys, artificially drained soils are included with soils that have aquic conditions.

Elements of aquic conditions:

1. **Saturation** is characterized by zero or positive pressure in the soil-water and can generally be determined by observing free water in an unlined auger hole. However, problems may arise in clayey soils with peds, where an unlined auger hole may fill with water flowing along faces of peds while the soil matrix is and remains unsaturated (bypass flow). Such free water may incorrectly suggest the presence of a water table, while the actual water table occurs at greater depth. Use of well-sealed piezometers or tensiometers is therefore recommended for measuring saturation. Problems may, however, still occur if water runs into piezometer slits near the bottom of the piezometer hole or if tensiometers with slowly reacting manometers are used. The first problem can be overcome by using piezometers with smaller slits, and the second by using transducer tensiometry, which reacts faster than manometers. Soils are considered wet if they have pressure heads greater than -1 kPa. Only macropores such as cracks between peds or channels are then filled with air, while the soil matrix is usually still saturated. Obviously, exact measurements of the wet state can only be obtained with tensiometers. For operational purposes, the use of piezometers is recommended as a standard method.

The duration of saturation required for creating aquic conditions is variable, depending on the soil environment, and is not specified.

Three types of saturation are defined:

a. Endosaturation.—The soil is saturated with water in all layers from the upper boundary of saturation to a depth of 200 cm or more from the mineral soil surface.

b. Episaturation.–The soil is saturated with water in one or more layers within 200 cm of the mineral soil surface and also has one or more unsaturated layers, with an upper boundary above 200 cm depth, below the saturated layer. The zone of saturation, i.e., the water table, is perched on top of a relatively impermeable layer.

c. Anthric saturation.—This variant of episaturation is associated with controlled flooding (for such crops as wetland rice and cranberries), which causes reduction processes in the saturated, puddled surface soil and oxidation of reduced and mobilized iron and manganese in the unsaturated subsoil.

2. The degree of **reduction** in a soil can be characterized by the direct measurement of redox potentials. Direct measurements should take into account chemical equilibria as expressed by stability diagrams in standard soil textbooks. Reduction and oxidation processes are also a function of soil pH. Accurate measurements of

boundaries if formed *in situ*, or with sharp boundaries after pedoturbation;

(2) Masses, i.e., soft bodies of variable shapes within the matrix; and

(3) Pore linings, i.e., zones of accumulation along pores which may be either coatings on pore surfaces or impregnations from the matrix adjacent to the pores.

b. Redox depletions.—These are zones of low chroma (2 or less) where either Fe-Mn oxides alone or both Fe-Mn oxides and clay have been stripped out, including:

(1) Iron depletions, i.e., zones which contain low amounts of Fe and Mn oxides but have a clay content similar to that of the adjacent matrix (often referred to as albans or neoalbans); and

(2) Clay depletions, i.e., zones which contain low amounts of Fe, Mn, and clay (often referred to as silt coatings or skeletans).

c. Reduced matrix.—This is a soil matrix which has a low chroma *in situ*, but undergoes a change in hue or chroma within 30 minutes after the soil material has been exposed to air.

d. In soils that have no visible redoximorphic features, a positive reaction to an α,α'-dipyridyl solution satisfies the requirement for redoximorphic features.

Field experience indicates that it is not possible to define a specific set of redoximorphic features that is uniquely characteristic of all the taxa in one particular category. Therefore color patterns that are unique to specific taxa are referenced in the keys.

Anthraquic conditions represent a special kind of aquic conditions which occur in soils that are cultivated and irrigated. Soils with anthraquic conditions must meet the requirements for aquic conditions and in addition have both of the following:

a. A tilled surface layer and a directly underlying slowly permeable layer which have, for three months or more per year in most years, both

(1) Saturation and reduction; and

(2) A chroma of two or less in the matrix; and

b. A subsurface horizon with one or more of the following:

(1) Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less in macropores; or

2. Are 2 mm or more thick between vertical faces of abutting peds; and

3. Constitute less than 15 percent (by volume) of the layer which they penetrate.

Linear extensibility (LE)

The linear extensibility (LE) of a soil layer is the product of the thickness, in centimeters, multiplied by the COLE of the layer in question. The LE of a soil is the sum of these products for all soil horizons.

Lithic contact

A lithic contact is the boundary between soil and a coherent underlying material. Except in ruptic-lithic subgroups the underlying material must be virtually continuous within the limits of a pedon. Cracks that can be penetrated by roots are few, and their horizontal spacing is 10 cm or more. The underlying material must be sufficiently coherent when moist to make hand-digging with a spade impractical, although the material may be chipped or scraped with a spade. If it consists of a single mineral, it must have a hardness by Mohs scale of 3 or more; otherwise, chunks of gravel size that can be broken out must not disperse during 15 hours of shaking in water or in a sodium hexametaphosphate solution. The underlying material considered here does not include diagnostic soil horizons such as a duripan or a petrocalcic horizon.

A lithic contact is diagnostic at the subgroup level if it is within 125 cm of the mineral soil surface of Oxisols and within 50 cm of the mineral soil surface of all other mineral soils.

***n* value**

The *n* value (Pons and Zonneveld, 1965) characterizes the relation between the percentage of water in a soil under field conditions and its percentages of inorganic clay and humus. The *n* value is helpful in predicting whether a soil can be grazed by livestock or can support other loads, and in predicting what degree of subsidence would occur after drainage. For mineral soil materials that are not thixotropic, the *n* value can be calculated by the formula:

$$n = (A - 0.2R)/(L + 3H)$$

A is the percentage of water in the soil in field condition, calculated on a dry-soil basis; R is the percentage of silt plus sand; L is the percentage of clay; and H is the percentage of organic matter (percent organic carbon multiplied by 1.724).

Few data are available in the United States for calculations of the *n* value, but the critical *n* value of 0.7 can be approximated closely in the field by a simple test of squeezing a soil sample in the hand. If the soil flows

Plinthite

Plinthite (Gr. *plinthos*, brick) is an iron-rich, humus-poor mixture of clay with quartz and other dilutents. It commonly occurs as dark red redox concentrations which usually form platy, polygonal, or reticulate patterns. Plinthite changes irreversibly to an ironstone hardpan or to irregular aggregates on exposure to repeated wetting and drying, especially if it is also exposed to heat from the sun. The lower boundary of a zone in which plinthite occurs is usually diffuse or gradual, but it may be abrupt at a lithologic discontinuity.

Generally, plinthite forms in a horizon that is saturated with water for some time during the year. Initially, iron is normally segregated in the form of soft, more or less clayey, red or dark red redox concentrations. These redox concentrations, however, are not considered plinthite unless there has been enough segregation of iron to permit their irreversible hardening on exposure to repeated wetting and drying. Plinthite in the soil is usually firm or very firm when the soil moisture content is near field capacity, and hard when the moisture content is below the wilting point. Plinthite does not harden irreversibly as a result of a single cycle of drying and rewetting; after a single drying, it will remoisten and can then be dispersed in large part by shaking in water with a dispersing agent.

In a moist soil, plinthite is soft enough so that it can be cut with a spade. After irreversible hardening, it is no longer considered plinthite but is called ironstone. Indurated ironstone materials can be broken or shattered with a spade but cannot be dispersed by shaking in water with a dispersing agent

Sequum and bisequum

The sequence of an eluvial horizon and the underlying B horizon, if one is present, is called a sequum. For example, an albic horizon and a spodic horizon directly below it, or a mollic epipedon and an underlying cambic horizon, or an argillic horizon and a *k* horizon directly below it, constitute a sequum. If two sequa are present in vertical sequence in a single soil, that sequence is called a bisequum.

Slickensides

Slickensides are polished and grooved surfaces that are produced by one soil mass sliding past another. Some slickensides occur at the lower boundary of a slip surface where a mass of soil moves downward on a relatively steep slope. Slickensides are very common in swelling clays that undergo marked changes in moisture content.

water is moving or because the environment is unfavorable for micro-organisms (e.g., if the temperature is less than 1°C); such a regime is not considered aquic.

It is not known how long a soil must be saturated to have an aquic moisture regime, but the duration must be at least a few days, because it is implicit in the concept that dissolved oxygen is virtually absent. Because dissolved oxygen is removed from ground water by respiration of micro-organisms, roots, and soil fauna, it is also implicit in the concept that the soil temperature is above biologic zero (5°C) for some time while the soil is saturated.

Very commonly, the level of ground water fluctuates with the seasons; it is highest in the rainy season, or in fall, winter, or spring if cold weather virtually stops evapotranspiration. There are soils, however, in which the ground water is always at or very close to the surface. A tidal marsh and a closed, landlocked depression fed by perennial streams are examples. The moisture regime in these soils is called *peraquic*.

Although the terms *aquic moisture regime* and *peraquic* are not used as either a criterion or a formative element for taxa, they are used in taxon descriptions as an aid in understanding genesis.

Aridic and torric (L. *aridus*, dry, and L. *torridus*,[12] hot and dry) **moisture regimes.**—These terms are used for the same moisture regime but in different categories of the taxonomy.

In the aridic (torric) moisture regime, the moisture control section is, in 6 or more out of 10 years,

1. Dry in all parts for more than half the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is above 5°C; *and*

2. Moist in some or all parts for less than 90 consecutive days when the soil temperature at a depth of 50 cm is above 8°C.

Soils that have an aridic or a torric moisture regime normally occur in arid climates. A few are in semiarid climates and either have physical properties that keep them dry, such as a crusty surface that virtually precludes infiltration of water, or they are very shallow over bedrock. There is little or no leaching in these moisture regimes, and soluble salts accumulate in the soil if there is a source of them.

The limits set for soil temperature exclude from these moisture regimes the very cold and dry polar regions and high elevations. The data available on the soils of

---

[12] *Torridus* is not a very satisfactory root, but a better one could not be found. Soils that have a torric moisture regime are hot and dry in summer, although they may not be hot throughout the year.

excess water. It seems likely that the moist and the dry pergelic regimes should be defined separately, but at present we have only fragmentary data on the dry soils of very high latitudes. Ice wedges and lenses are normal in such soils in the United States.

Cryic (Gr. *kryos*, coldness; meaning very cold soils).—Soils in this temperature regime have a mean annual temperature higher than 0°C but lower than 8°C.

1. In mineral soils, the mean summer soil temperature (June, July, and August in the northern hemisphere and December, January, and February in the southern hemisphere) either at a depth of 50 cm from the soil surface or at a lithic or paralithic contact, whichever is shallower, is as follows:

    a. If the soil is not saturated with water during some part of the summer and

        (1) If there is no O horizon: lower than 15°C; or

        (2) If there is an O horizon: lower than 8°C; or

    b. If the soil is saturated with water during some part of the summer and

        (1) If there is no O horizon: lower than 13°C; or

        (2) If there is an O horizon or a histic epipedon: lower than 6°C.

2. In organic soils, the soil is either:

    a. Frozen in some layer within the control section in most years 2 months after the summer solstice; i.e., the soil is very cold in winter but warms up slightly in summer; or

    b. Not frozen in most years below a depth of 5 cm from the soil surface; i.e., the soil is cold throughout the year but, because of marine influence, does not freeze in most years.

Cryic soils that have an aquic moisture regime commonly are churned by frost. All isofrigid (see below) soils without permafrost are considered to have a cryic temperature regime.

Frigid.—The concept of the frigid soil temperature regime and of other soil temperature regimes listed below are used chiefly in defining classes of soils in the low categories. A soil with a frigid regime is warmer in summer than a soil with a cryic regime, but its mean annual temperature is lower than 8°C, and the difference between mean summer and mean winter soil temperatures (June-July-August and December-January-February) is more than 5°C either at a depth of 50 cm from the soil surface or at a lithic or paralithic contact, whichever is shallower.

Mesic.—The mean annual soil temperature is 8°C or higher but lower than 15°C, and the difference between mean summer and mean winter soil temperatures is more than 5°C either at a depth of 50 cm from the soil surface or at a lithic or paralithic contact, whichever is shallower.

Thermic.—The mean annual soil temperature is 15°C or higher but lower than 22°C, and the difference between mean summer and mean winter soil temperatures is more than 5°C either at a depth of 50 cm from the soil surface or at a lithic or paralithic contact, whichever is shallower.

Hyperthermic.—The mean annual soil temperature is 22°C or higher, and the difference between mean summer and mean winter soil temperatures is more than 5°C either at a depth of 50 cm from the soil surface or at a lithic or paralithic contact, whichever is shallower.

If the name of a soil temperature regime has the prefix *iso*, the mean summer and mean winter soil temperatures for June, July, and August and for December, January, and February differ by less than 5°C at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower.

Isofrigid.—The mean annual soil temperature is lower than 8°C.

Isomesic.—The mean annual soil temperature is 8°C or higher but lower than 15°C.

Isothermic.—The mean annual soil temperature is 15°C or higher but lower than 22°C.

Isohyperthermic.—The mean annual soil temperature is 22°C or higher.

Spodic materials

Spodic materials have formed in an illuvial horizon that normally underlies a histic, an ochric, or an umbric epipedon or an albic horizon. In most undisturbed areas spodic materials underlie an albic horizon. They may occur within an umbric epipedon or Ap horizon.

A horizon consisting of spodic materials normally has an optical-density-of-oxalate-extract (ODOE) value of 0.25 or more, and that value must be at least two times as high as the ODOE value for an overlying eluvial horizon. This increase in ODOE value indicates an accumulation of translocated organic materials in an illuvial horizon. Soils with spodic materials show evidence that organic materials and aluminum, with or without iron, have been moved from an eluvial to an illuvial horizon. The morphological, chemical, and physical properties of spodic materials are as follows.

Definition of spodic materials

Spodic materials are mineral soil materials that do not have all the properties of an argillic or a kandic horizon, are dominated by illuvial active amorphous materials composed of organic matter and aluminum, with or without iron, and have both.

1. A pH value in water (1:1) of 5.9 or less and an organic-carbon content of 0.6 percent or more; and

2. One or more of the following:

a An overlying albic horizon which extends horizontally through 50 percent or more of each pedon, and have, directly under the albic horizon, colors, moist (crushed and smoothed sample), as follows:

(1) A hue of 5YR or redder; or

(2) A hue of 7.5YR, color value of 5 or less, and chroma of 4 or less; or

(3) A hue of 10YR or neutral and a color value and chroma of 2 or less; or

(4) A color of 10YR 3/1; or

b. One of the colors listed above or a hue of 7.5YR, color value, moist, of 5 or less, and chroma of 5 or 6 (crushed and smoothed sample), and one or more of the following morphologic or chemical properties:

(1) Cementation by organic matter and aluminum, with or without iron, in 50 percent or more of each pedon, and very firm or firmer consistence in the cemented part; or

(2) Ten percent or more cracked coatings on sand grains; or

(3) Aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.50 or more, and half that amount or less in an overlying umbric (or subhorizon of an umbric) epipedon, or an ochric epipedon or albic horizon; or

(4) An optical-density-of-oxalate-extract (ODOE) value of 0.25 or more, and a value half as high or lower in an overlying umbric (or subhorizon of an umbric) epipedon, or an ochric epipedon or albic horizon

Sulfidic materials

Sulfidic materials contain oxidizable sulfur compounds, and are mineral or organic soil materials with a pH value of more than 3.5 which, if incubated as a layer 1 cm thick under moist aerobic conditions (field capacity) at room temperature, show a drop in pH of 0.5 or more units to a pH value of 4.0 or less (1:1 by weight in water, or in a minimum of water to permit measurement) within 8 weeks.

Sulfidic materials accumulate as a soil or sediment which is permanently saturated, generally with brackish water. The sulfates in the water are biologically reduced to sulfides as the materials accumulate. Sulfidic materials most commonly accumulate in coastal marshes near the mouths of rivers that carry noncalcareous sediments, but they may occur in fresh-water marshes if there is sulfur in the water. Upland sulfidic materials may have accumulated in a similar manner in the geologic past.

If a soil containing sulfidic materials is drained, or if sulfidic materials are otherwise exposed to aerobic conditions, the sulfides oxidize and form sulfuric acid. The pH value, which normally is near neutrality before drainage or exposure, may drop below 3. The acid may induce formation of iron and aluminum sulfates. The iron sulfate, jarosite, may segregate to form the yellow mottles that commonly characterize a sulfuric horizon. The transition from sulfidic materials to a sulfuric horizon normally requires very few years and may occur within a few weeks. A sample of sulfidic materials, if air-dried slowly in shade for about 2 months with occasional remoistening, becomes extremely acid.

Weatherable minerals

Several references are made to weatherable minerals in the text of this and subsequent chapters. Obviously, the stability of a mineral in a soil is a partial function of the soil moisture regime. Where weatherable minerals are referred to in the definitions of diagnostic horizons and of various taxa in this taxonomy, a humid climate, either present or past, is always assumed. Minerals that are included in the meaning of weatherable minerals are as follows:

1. Clay minerals: All 2:1 lattice clays except one which is currently considered to be an aluminum-interlayered chlorite. Sepiolite, talc, and glauconite are also included in this group of weatherable clay minerals, although they are not everywhere of clay size.

2. Silt- and sand-size minerals (0.02 to 0.2 mm in diameter). Feldspars, feldspathoids, ferromagnesian minerals, glass, micas, zeolites, and apatite.

Obviously, this is a restricted meaning of the term *weatherable minerals*. The intent is to include, in the definitions of diagnostic horizons and various taxa, only those weatherable minerals which are unstable in a humid climate compared to other minerals, such as quartz and 1:1 lattice clays, but which are more resistant to weathering than calcite.

LITERATURE CITED

Brewer, R. 1964. Fabric and mineral analysis of soil. John Wiley and Sons, Inc., New York, London, Sydney. 470 pp.

Pons, L.J., and I.S. Zonneveld. 1965. Soil ripening and soil classification. Initial soil formation in alluvial deposits and a classification of the resulting soils. Int. Inst. Land Reclam. and Impr. Pub. 13. Wageningen, The Netherlands. 128 pp.

2. Show evidence of the cellular structure of the plants from which they are derived; and

3. Are either 2 cm or less in their smallest dimension, or are decomposed enough so they can be crushed and shredded with the fingers.

Pieces of wood which are larger than 2 cm in cross section and which are so undecomposed that they cannot be crushed and shredded with the fingers, such as large branches, logs, and stumps, are not considered to be fibers but coarse fragments (comparable to gravel, stones, and boulders in mineral soils).

Fibric soil materials (L. *fibra*, fiber)

Fibric soil materials are organic soil materials which either:

1. Contain three fourths[2] or more (by volume) fibers after rubbing, excluding coarse fragments; *or*

2. Contain two fifths or more (by volume) fibers after rubbing, excluding coarse fragments; and yield color values and chromas of 7/1, 7/2, 8/1, 8/2, or 8/3 (Munsell designations) on white chromatographic or filter paper that is inserted into a paste made of the soil materials in a saturated sodium pyrophosphate solution.

Hemic soil materials (Gr. *hemi*, half; implying intermediate decomposition)

Hemic soil materials are intermediate in their degree of decomposition between the less decomposed fibric and more decomposed sapric materials. Their morphological features give intermediate values for fiber content, bulk density, and water content. They are partly altered both physically and biochemically.

Sapric soil materials (Gr. *sapros*, rotten)

These are the most highly decomposed of the three kinds of organic soil materials. They have the smallest amount of plant fiber, the highest bulk density, and the lowest water content on a dry-weight basis at saturation. Sapric soil materials are commonly very dark gray to black. They are relatively stable, i.e., they change very little physically and chemically with time in comparison to other organic soil materials.

Sapric materials have the following characteristics:

1. Their fiber content, after rubbing, is less than one sixth (by volume), excluding coarse fragments; and

2. Their sodium-pyrophosphate-extract color on white chromatographic or filter paper is below or to the right of a line drawn to exclude blocks 5/1, 6/2, and 7/3 (Munsell designations). If few or no fibers can be

---

[2] Fractions are used rather than percentages to avoid implying a higher degree of accuracy than is justified.

detected and the color of the pyrophosphate extract is to the left or above this line, the possibility that the material is limnic must be considered.

Humilluvic material

Humilluvic material, i.e., illuvial humus, accumulates in the lower parts of some organic soils if they are acid and have been drained and cultivated. The humilluvic material has a younger C^{14} age than the overlying organic materials. It has very high solubility in sodium pyrophosphate and rewets very slowly after drying. Most commonly it accumulates near a contact with a sandy mineral horizon

To be recognized as a differentia in classification, the humilluvic material must constitute one half or more (by volume) of a layer 2 cm or more thick.

Limnic materials

The presence or absence of limnic deposits is taken into account in the higher categories of organic soils (Histosols, see below), while the nature of such deposits is considered in the lower categories. Limnic materials include both organic and inorganic materials that were either (1) deposited in water by precipitation or through the action of aquatic organisms, such as algae or diatoms, or (2) derived from underwater and floating aquatic plants and subsequently modified by aquatic animals. They include coprogenous earth (sedimentary peat), diatomaceous earth, and marl.

Coprogenous earth

A coprogenous-earth (sedimentary peat) layer is a limnic layer which:

1. Contains many fecal pellets with diameters between a few hundredths and a few tenths of a millimeter; and

2. Has a color value, moist, of 4 or less; and

3. Either forms a slightly viscous water suspension and is slightly plastic but not sticky, or shrinks upon drying to form clods that are difficult to rewet and often tend to crack along horizontal planes; and

4. Normally contains almost no visible fragments of plants; and

5. Either yields a saturated sodium-pyrophosphate extract on white chromatographic or filter paper that has a higher color value and lower chroma than 10 YR 7/3 (Munsell designations), or has a cation-exchange capacity of less than 240 cmol(+) per kg organic matter (measured by loss on ignition), or both.

Diatomaceous earth

A diatomaceous-earth layer is a limnic layer which.

1. If not previously dried, has a matrix color value of 3, 4, or 5, which changes irreversibly on drying as the

within that depth are fibric and three fourths or more of the fiber volume is derived from sphagnum or other mosses, or (2) the materials have a bulk density of less than 0.1 g/cm^3; otherwise, the surface tier extends from the soil surface to a depth of 30 cm.

On some organic soils, a surface mineral layer less than 40 cm thick is present as a result of flooding, volcanic eruptions, additions of mineral materials to increase soil strength or reduce frost hazard, or other causes. If such a mineral layer is less than 30 cm thick, it constitutes the upper part of the surface tier; if it is 30 to 40 cm thick, it constitutes the whole surface tier and part of the subsurface tier.

Subsurface tier

The subsurface tier is normally 60 cm thick. If, however, the control section ends at a shallower depth (at a lithic or paralithic contact or a water layer, or in permafrost), the subsurface tier extends from the lower boundary of the surface tier to the lower boundary of the control section. It includes any unconsolidated mineral layers that may be present within those depths.

Bottom tier

The bottom tier is 40 cm thick unless the control section has its lower boundary at a shallower depth (at a lithic or paralithic contact or a water layer, or in permafrost).

Chapter 4

Family and Series Differentiae

FAMILY DIFFERENTIAE FOR MINERAL SOILS

To distinguish families of mineral soils within a subgroup, the following differentiae are used. They are listed and defined in the same sequence in which the descriptive adjectives relating to each differentia appear in the family names.

Particle-size classes

Mineralogy classes

Calcareous and reaction classes

Soil temperature classes

Soil depth classes

Soil consistence classes

Classes of coatings

Classes of cracks

Particle-size classes

The term *particle size* is used to characterize the grain-size composition of a whole soil, while the term *texture* is used in describing its fine-earth fraction, which consists of particles with a diameter of less than 2.0 mm.

The particle-size classes of this taxonomy represent a compromise between conventional divisions in pedologic and in engineering classifications. Engineering classifications have set the limit between sand and silt at a diameter of 74 microns, while pedologic classifications have put it at either 50 or 20 microns. Engineering classifications have been based on grain-size percentages by weight in the soil fraction less than 74 mm in diameter, while textural classes in pedologic classifications have been based on percentages by weight in the fraction less than 2.0 mm in diameter. In engineering classifications, the very-fine-sand separate (diameter between 0.05 mm and 0.1 mm) has been subdivided by the 74-micron limit. In defining the particle-size classes for this taxonomy, a similar division has been made, but in a different way. A fine sand or loamy fine sand normally contains an appreciable amount of very fine sand, but the very-fine-sand fraction is mostly coarser than 74 microns. A silty sediment such as loess may also contain an appreciable amount of very fine sand, most of which, however, is finer than 74 microns. So in designing the particle-size

Loamy.[1]—In the fine-earth fraction, a texture of loamy very fine sand, very fine sand, or finer, including less than 35 percent (by weight) clay; in the whole soil, less than 35 percent (by volume) rock fragments.

Coarse-loamy. In the fraction less than 75 mm in diameter, 15 percent or more (by weight) particles with diameters of 0.1 to 75 mm (fine sand or coarser, including rock fragments up to 7.5 cm in diameter); in the fine-earth fraction, less than 18 percent (by weight) clay.

Fine-loamy. In the fraction less than 75 mm in diameter, 15 percent or more (by weight) particles with diameters of 0.1 to 75 mm (fine sand or coarser, including rock fragments up to 7.5 cm in diameter); in the fine-earth fraction, 18 to 35 percent (by weight) clay (Vertisols are excluded).

Coarse-silty. In the fraction less than 75 mm in diameter, less than 15 percent (by weight) particles with diameters of 0.1 to 75 mm (fine sand or coarser, including rock fragments up to 7.5 cm in diameter); in the fine-earth fraction, less than 18 percent (by weight) clay.

Fine-silty. In the fraction less than 75 mm in diameter, less than 15 percent (by weight) particles with diameters of 0.1 to 75 mm (fine sand or coarser, including rock fragments up to 7.5 cm in diameter); in the fine-earth fraction, 18 to 35 percent (by weight) clay (Vertisols are excluded).

Clayey.[2]— In the fine-earth fraction, 35 percent or more (by weight) clay; in the whole soil, less than 35 percent (by volume) rock fragments.

Fine. 35 to 60 percent (by weight) clay (30 to 60 percent in Vertisols) in the fine-earth fraction.

Very fine. 60 percent or more (by weight) clay in the fine-earth fraction.

---

[1] If the ratio of (percent water retained at 1500 kPa tension minus percent organic carbon) to the percentage of measured clay is 0.6 or more in half or more of the control section, then the percentage of clay is considered to be 2.5 times (percent water retained at 1500 kPa tension minus percent organic carbon), but no more than 100. Carbonates of clay size are not considered to be clay but are treated as silt in all particle-size classes

[2] See preceding footnote.

Modifiers that replace names of particle-size classes[3]

There are two situations in which particle-size class names are not used. In one, the name is redundant. Psamments and Psammaquents are sandy by definition, so no particle-size modifier is used in the family names of those soils.

In the second situation particle-size analysis is difficult to apply, which is the case with soil materials that are derived from volcanic ejecta and/or have a high content of sequioxides and organic matter. Normal particle-size classes do not characterize these components adequately, especially as they often cannot be readily dispersed and the results of dispersion are variable. Consequently, normal particle-size class names are not used for those parts of soils that have andic soil properties or a high amount of volcanic glass, as is the case with Andisols and many andic and vitrandic subgroups of other soil orders. In addition, most Cryods and Cryaquods and a few other Spodosols that are not identified in andic subgroups have andic soil properties in some horizons within the particle-size control section, and particle-size class names are not used for these horizons.[4]

The following is a list of modifiers used as substitutes for particle-size class names, together with the criteria for each. These criteria combine particle-size and mineralogical properties and take the place of both.

1. Substitutes for the fragmental particle-size class:

These classes have a fine-earth component of less than 10 percent of the total volume.

Pumiceous - In the whole soil, more than 60 percent (by weight) volcanic ash, cinders, lapilli, pumice and

---

[3] Definitions of the geologic terms used in the substitute particle-size classes are generally the same as in: Bates, R.L., and J.A. Jackson, (Eds). 1980. Glossary of Geology. 2nd ed. American Geological Institute, Falls Church, VA. 751 pp. However, different definitions are used here for the following terms:

> Cinders. Uncemented, juvenile, vitric, vesicular pyroclastic material, more than 2.0 mm in at least one dimension, with an apparent specific gravity (including vesicles) of more than 1.0 and less than 2.0 g/cm^3.
>
> Lapilli: Nonvesicular or slightly vesicular pyroclastics, 2.0 to 76 mm in at least one dimension, with an apparent specific gravity of 2.0 or more g/cm^3.
>
> Pumice-like: Vesicular pyroclastic materials other than pumice that have an apparent specific gravity (including vesicles) of less than 1.0 g/cm^3.

[4] Particle-size class names are applied, although with reservations, to spodic horizons that do not have andic soil properties but contain significant amounts of organic matter. Somewhat different classes probably should be used for most families of Spodosols, because some series that otherwise seem reasonably homogeneous are split at the family level by the particle-size classes. But alternatives have not yet been sufficiently tested.

pumice-like[5] fragments with diameters of more than 1 mm; in the fraction coarser than 2.0 mm, two thirds or more (by volume) pumice or pumice-like fragments.

Cindery - In the whole soil, more than 60 percent (by weight) volcanic ash, cinders, lapilli, pumice and pumice-like fragments with diameters of more than 1 mm; in the fraction coarser than 2.0 mm, less than two thirds (by volume) pumice and pumice-like fragments.

2. Substitutes for the non-fragmental particle-size classes:

These classes have a fine-earth component of 10 percent or more of the total volume.

Ashy - Less than 35 percent (by volume) rock fragments; a fine-earth fraction which contains 30 percent or more (by weight) particles between 0.02 and 2.0 mm in diameter and which has either:

a. Andic soil properties, and a water content at 1500 kPa tension of less than 30 percent on undried samples and less than 12 percent on dried samples; or

b. No andic soil properties, and a total of 30 percent or more of the 0.02-to-2.0-mm fraction (by grain count) consisting of volcanic glass, glass aggregates, glass-coated grains, and other vitric volcaniclastics.

Ashy-pumiceous - 35 percent or more (by volume) rock fragments, of which two thirds or more (by volume) are pumice or pumice-like fragments; an ashy fine-earth fraction.

Ashy-skeletal - 35 percent or more (by volume) rock fragments, of which less than two-thirds (by volume) are pumice and pumice-like fragments; an ashy fine-earth fraction.

Medial - A fine-earth fraction which has andic soil properties, and which has a water content at 1500 kPa tension of 12 percent on air-dried samples and of 30 to 100 percent on undried samples; less than 35 percent (by volume) rock fragments.

Medial-pumiceous - 35 percent or more (by volume) rock fragments, of which two thirds or more (by volume) are pumice or pumice-like fragments; a medial fine-earth fraction.

Medial-skeletal - 35 percent or more (by volume) rock fragments, of which less than two thirds (by volume) are pumice or pumice-like fragments; a medial fine-earth fraction.

Hydrous - A fine-earth fraction which has andic soil properties, and which has a water content at 1500 kPa

---

[5] See footnote 3.

tension of 100 percent or more on undried samples; less than 35 percent (by volume) rock fragments.

Hydrous-pumiceous - 35 percent or more (by volume) rock fragments, of which two thirds or more (by volume) are pumice or pumice-like fragments; a hydrous fine-earth fraction.

Hydrous-skeletal - 35 percent or more (by volume) rock fragments, of which less than two thirds (by volume) are pumice or pumice-like fragments; a hydrous fine-earth fraction.

Control section for particle-size classes or their substitutes

The particle-size and substitute class names listed above are applied to certain horizons, or to the soil materials within specific depth limits, which have been designated as the *particle-size control section*. The lower boundary of the control section may be at a specified depth (in centimeters) from the mineral soil surface, or at the upper boundary of a root-limiting layer, i.e., a duripan, a fragipan, a petrocalcic, petrogypsic, or placic horizon, or continuous ortstein; or at a lithic, paralithic, or petroferric contact. The following list of particle-size control sections for particular kinds of soils is arranged as a key.[6] The control sections are as follows:

1. For soils that have, within 36 cm of the mineral soil surface,

    a. A root-limiting layer: Between the mineral soil surface and the root-limiting layer;

    b. A soil temperature of 0°C or lower, 2 months after the summer solstice: Between the mineral soil surface and a depth of 36 cm.

2. For Andisols: Between either the mineral soil surface or the upper boundary of an organic layer with andic soil properties, whichever is shallower, and the shallowest of the following: (a) a depth of 100 cm, or (b) a root-limiting layer or contact, or (c) a depth of 25 cm below the level to which the soil is frozen 2 months after the summer solstice.

3. For those great groups of Alfisols, Spodosols, and Ultisols that have a fragipan or spodic horizon in or above an argillic or a kandic horizon; for Oxisols; and for other soils that do not have an argillic, kandic, or natric horizon: Between the lower boundary of an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and the shallowest of the

---

6 This key, like the others in Soil Taxonomy, is designed in such a way that the reader makes the correct classification by going through the key systematically, starting at the beginning and eliminating one by one any classes which include criteria that do not fit the soil in question The soil belongs into the first class listed for which it meets the criteria

following: (a) a depth of 100 cm, or (b) a root-limiting layer or contact, or (c) a depth of 25 cm below the level to which the soil is frozen 2 months after the summer solstice.

4. For those Alfisols, Ultisols, and great groups of Aridisols and Mollisols which have an argillic, a kandic, or a natric horizon that has its upper boundary within 100 cm of the mineral soil surface and its lower boundary at a depth of 25 cm or more, or which are in a grossarenic subgroup, one of the following:

a. If there are no horizons or layers of strongly contrasting particle sizes (defined below), and there is no root-limiting layer or contact at a depth of less than 50 cm from the top of the argillic, kandic, or natric horizon: Either the whole argillic, kandic, or natric horizon if less than 50 cm thick, or its upper 50 cm; or

b. If there are horizons or layers of strongly contrasting particle sizes within or below the argillic, kandic, or natric horizon and within 100 cm of the mineral soil surface: Between the upper boundary of the argillic, kandic, or natric horizon and either a depth of 100 cm from the mineral soil surface or a root-limiting layer or contact, whichever is shallower; or

c. If there is a root-limiting layer or contact directly below the argillic, kandic, or natric horizon: Between the upper boundary of the argillic, kandic, or natric horizon and either the root-limiting layer or contact, or a depth of 50 cm from the top of the argillic, kandic, or natric horizon, whichever is shallower.

5. For those Alfisols, Ultisols, and great groups of Aridisols and Mollisols which have an argillic, a kandic, or a natric horizon that has its upper boundary at a depth of 100 cm or more from the mineral surface, and which are not in a grossarenic subgroup: Between the lower boundary of an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 100 cm.

6. For other soils which have an argillic or a natric horizon that has its lower boundary at a depth of less than 25 cm from the mineral soil surface: Between the upper boundary of the argillic or natric horizon and either a depth of 100 cm or a root-limiting layer or contact, whichever is shallower.

Strongly contrasting particle-size classes

In general, the weighted average particle size of the whole control section determines what particle-size or substitute class name is used for a soil family. If a particle-size class name applies for one part and a substitute class name for the remaining part of the control section, the name for the thicker part is used for that soil family.

If, however, the particle-size control section consists of two parts with strongly contrasting particle-size or substitute classes (listed below) and if the transition zone between them is less than 12.5 cm thick, both class names are used. For example, if the weighted average particle size of the control section's upper part is loamy fine sand and that of the lower part is clay, with a transition zone of less than 12.5 cm, the family particle-size class of that soil is *sandy over clayey*. If the particle-size control section includes more than one pair of the strongly contrasting classes listed below, then the pair of adjacent classes that contrast most strongly is used in classifying the soil family; however, substitute class names are used only if the soil materials to which they apply extend 10 cm or more into the upper part of the particle-size control section.

The following particle-size or substitute classes are considered strongly contrasting if the transition zone between the two parts of the particle-size control section is less than 12.5 cm thick:

1. Ashy over clayey.
2. Ashy over loamy-skeletal.
3. Ashy over loamy.
4. Ashy over medial-skeletal.
5. Ashy over medial if the water content at 1500 kPa tension in dried samples of the fine-earth fraction is 10 percent or less for the ashy materials and 15 percent or more for the medial materials.
6. Ashy over pumiceous or cindery if there is an absolute difference of 20 percent or more between volumes of rock fragments in the two parts of the control section.
7. Ashy over sandy or sandy-skeletal.
8. Ashy-skeletal over fragmental or cindery if the volume of the fine-earth fraction is 35 percent or more (absolute) greater in the ashy-skeletal part than in the fragmental or cindery part.
9. Cindery over loamy.
10. Cindery over medial-skeletal.
11. Cindery over medial.
12. Clayey over fine-silty if there is an absolute difference of 25 percent or more between clay percentages of the fine-earth fraction in the two parts of the control section.
13. Clayey over fragmental.
14. Clayey over loamy if there is an absolute difference of 25 percent or more between clay

percentages of the fine-earth fraction in the two parts of the control section.

15. Clayey over loamy-skeletal if there is an absolute difference of 25 percent or more between clay percentages of the fine-earth fraction in the two parts of the control section.

16. Clayey over sandy or sandy-skeletal.

17. Clayey-skeletal over sandy or sandy-skeletal.

18. Coarse-loamy over clayey.

19. Coarse-loamy over fragmental.

20. Coarse-loamy over sandy or sandy-skeletal if the coarse-loamy material contains less than 50 percent fine or coarser sand

21. Coarse-silty over clayey.

22. Coarse-silty over sandy or sandy-skeletal.

23. Fine-loamy over clayey if there is an absolute difference of 25 percent or more between clay percentages of the fine-earth fraction in the two parts of the control section

24. Fine-loamy over fragmental.

25. Fine-loamy over sandy or sandy-skeletal.

26. Fine-silty over clayey if there is an absolute difference of 25 percent or more between clay percentages of the fine-earth fraction in the two parts of the control section.

27. Fine-silty over fragmental.

28. Fine-silty over sandy or sandy-skeletal.

29. Hydrous over clayey-skeletal.

30. Hydrous over clayey.

31. Hydrous over fragmental.

32. Hydrous over loamy-skeletal.

33. Hydrous over loamy.

34. Hydrous over sandy or sandy-skeletal.

35. Loamy over sandy or sandy-skeletal if the loamy material contains less than 50 percent fine or coarser sand.

36. Loamy over pumiceous or cindery.

37. Loamy-skeletal over clayey if there is an absolute difference of 25 percent or more between clay percentages of the fine-earth fraction in the two parts of the control section.

38. Loamy-skeletal over fragmental if the volume of the fine-earth fraction is 35 percent or more (absolute) greater in the loamy-skeletal part than in the fragmental part.

39. Loamy-skeletal over sandy or sandy-skeletal if the loamy material has less than 50 percent fine or coarser sand.

40. Medial over ashy if the water content at 1500 kPa tension in dried samples of the fine-earth fraction is 15 percent or more for the medial materials and 10 percent or less for the ashy materials.

41. Medial over clayey-skeletal.

42. Medial over clayey.

43. Medial over fragmental.

44. Medial over hydrous.

45. Medial over loamy-skeletal.

46. Medial over loamy.

47. Medial over pumiceous or cindery.

48. Medial over sandy or sandy-skeletal.

49. Pumiceous or ashy-pumiceous over loamy.

50. Pumiceous or ashy-pumiceous over medial-skeletal.

51. Pumiceous or ashy-pumiceous over medial.

52. Pumiceous or ashy-pumiceous over sandy or sandy-skeletal.

53. Sandy over clayey.

54. Sandy over loamy if the loamy material contains less than 50 percent fine or coarser sand.

55. Sandy-skeletal over loamy if the loamy material contains less than 50 percent fine or coarser sand.

The purpose in setting up classes of strongly contrasting particle sizes has been to identify changes in pore-size distribution which are not identified in higher soil categories and which seriously affect the movement and retention of water. The above list has been compiled for use in grouping the soil series of the United States into families, and is not intended as a complete list. For example, "fine sand over coarse sand" is a pair of strongly contrasting particle-size classes common among Udipsamments in western Europe, but not included here because it is much less common in the United States.

<u>Choice of 7 or 11 particle-size classes</u>

Only seven particle-size class names are used for families of shallow soils and those in lithic, arenic, and grossarenic subgroups.

With families of Ultisols not included in the preceding item, subclasses of the loamy particle-size class, but not those of the clayey class, are used.

they are not mentioned in families of Quartzipsamments because these soils are siliceous by definition.

Obviously, it is normally impossible to be certain what percentages of the different kinds of clay minerals are present in a soil. Quantitative methods of identification are still subject to change, and although much progress has been made in the past few decades, an element of judgement still enters into the estimation. However, one does not have to depend exclusively on X-ray, surface, and DTA determinations. Other physical and chemical properties, e.g., changes in volume, cation-exchange capacity, and consistence, can suggest the mineralogy of many clayey soils.

The clay mineralogy descriptions for clayey soils are based on the weighted average percentages of the control section's fine-earth fraction.

Calcareous and reaction classes

In the following, presence or absence of carbonates in mineral soils and reaction classes are treated together because they are so intimately related; e.g., a calcareous horizon cannot be strongly acid. Two classes identifying the presence or absence of carbonates, *calcareous* and *noncalcareous*, are defined for selected taxa. Their control section is one of the following: (1) between 25 and 50 cm from the mineral soil surface, or (2) between a depth of 25 cm from the mineral soil surface and a lithic or paralithic contact at a depth between 25 and 50 cm, or (3) a layer directly above a lithic or paralithic contact that is less than 25 cm below the mineral soil surface. Definitions of the two classes are as follows:

Calcareous.—The fine-earth fraction effervesces in all parts with cold dilute HCl.

Noncalcareous.—The fine-earth fraction does not effervesce in all parts with cold dilute HCl. The term *noncalcareous* is not used as part of the family name.

It should be noted that a soil containing dolomite is calcareous, and that effervescence of dolomite, when treated with cold dilute HCl, is slow.

The control section for reaction classes is the same as for particle-size classes. Three classes, *acid*, *nonacid*, and *allic*, are defined for use in selected taxa, as follows:

Acid.—The pH is less than 5.0 in 0.01 M $CaCl_2$ (2:1) throughout the control section (about 5.5 in H_2O, 1:1).

Nonacid.—The pH is 5.0 or more in 0.01 M $CaCl_2$ (2:1) in some or all layers of the control section. The term *nonacid* is not used in the family name of calcareous soils.

Allic.—A layer 30 cm or more thick within the control section contains more than 2 cmol(+) of KCl-extractable Al per kg soil in the less-than-2.0-mm fraction.

The terms *acid* and *nonacid* are used only in names of certain families of Entisols and Aquepts; they are not used in sandy, sandy-skeletal, cindery, pumiceous, and fragmental families of these taxa, or in Sulfaquepts and Fragiaquepts, or in families with a carbonatic or gypsic mineralogy. The term *allic* is used only in names of Oxisol families.

Calcareous classes, if appropriate, are applied to the same taxa as reaction classes and are also used in family names of Aquolls, except Calciaquolls and Aquolls with an argillic horizon. Calcareous and reaction class names are not used in soil families that have a carbonatic or gypsic mineralogy. Because *calcareous* implies *nonacid*, the term *nonacid* is omitted as redundant if a soil family is termed *calcareous*. If a soil is both nonacid and noncalcareous, only the class name *nonacid* is used (*noncalcareous* is never used in a family name). The term *calcareous*, when used as a family modifier, is considered a subclass of mineralogy and is added to the mineralogy class name in parentheses, e.g.: fine-loamy, mixed (calcareous), mesic Typic Haplaquolls.

Soil temperature classes

Soil temperature classes, as named and defined here, are used as family differentiae in all orders. The names are used as family modifiers unless the criteria for a higher taxon carry the same limitation. Thus *frigid* is implied in all boric suborders and cryic great groups, and would be redundant if used in the names of families within these classes of soils.

The Celsius (centigrade) scale is the standard. It is assumed that the temperature is that of a soil that is not being irrigated.

For soil families that have a difference of 5°C or more between mean summer (June, July, and August in the northern hemisphere) and mean winter (December, January, and February in the northern hemisphere) soil temperatures, either at a depth of 50 cm from the soil surface or at a lithic or paralithic contact, whichever is shallower, the soil temperature classes, defined in terms of the mean annual soil temperature, are as follows:

Frigid.— Lower than 8°C.

Mesic.— 8° to 15°C.

Thermic.— 15° to 22°C.

Hyperthermic.— 22°C or higher.

For soil families that have a difference of less than 5°C between mean summer and mean winter soil temperatures, either at a depth of 50 cm from the soil surface or at a lithic or paralithic contact, whichever is shallower, the soil temperature classes, defined in terms of the mean annual soil temperature, are as follows:

Isofrigid.— Lower than 8°C.

Isomesic.— 8° to 15°C.

Isothermic.— 15° to 22°C.

Isohyperthermic.— 22°C or higher.

Other characteristics

Several other soil characteristics besides those mentioned above are considered in particular taxa for grouping series into families. These characteristics include depth of soil, consistence, coatings on sands, and permanent cracks.

Depth of soil

Distinctions according to soil depth are made in some great groups and in arenic, grossarenic, and lithic subgroups. But at the family level some other soils should also be grouped according to depth, e.g., soils which have a shallow paralithic contact with weakly consolidated rock, such as clay shale, that is too compact for penetration by roots. One soil-depth class name, *shallow*, is used to characterize certain soil families that have one of the following depths (from the mineral soil surface):

Shallow.—Either:

1. Less than 50 cm to the upper boundary of a duripan or of a petrocalcic or petrogypsic horizon, or to a lithic, paralithic, or petroferric contact. Used for families in all great groups of Alfisols, Andisols, Aridisols, Entisols, Inceptisols, Mollisols, Spodosols, and Ultisols, except in the family names of lithic subgroups of these orders, where it would be redundant. Or:

2. Less than 100 cm to a lithic, paralithic, or petroferric contact. Used for families of Oxisols.

Consistence

In this taxonomy, some cemented horizons, e.g., a duripan, serve as differentiae in categories above the family, while others, such as a cemented spodic horizon (ortstein), do not. But no single family should include soils both with and without a continuous, shallow, cemented horizon. In Spodosols, in particular, a cemented spodic horizon has to be used as a family differentia. The following two soil consistence classes are defined for Spodosol families:

Ortstein.—All or part of the spodic horizon, when moist, is at least weakly cemented into a massive horizon that is present in more than half of each pedon.

Noncemented.—The spodic horizon, when moist, is not cemented into a massive horizon in one half or more of each pedon.

Cementation of a small volume within the spodic horizon into concretions does not constitute cementation to form a massive horizon. While the name of a family of noncemented Spodosols normally does not have a modifier to indicate lack of cementation, the name of a family of cemented Spodosols contains the modifier *ortstein*.

A cemented calcic or gypsic horizon is not identified in the family name. Many calcic and some gypsic horizons are weakly cemented and some are indurated. The recognition of petrocalcic and petrogypsic horizons is expected to meet most, if not all, the needs for recognition of cementation in those horizons. Therefore, taxa with a petrocalcic or petrogypsic horizon do not have a family modifier indicating cementation.

Classes of coatings

Despite the emphasis given to particle-size classes in the taxonomy, variability remains in the sandy particle-size class, which includes sands and loamy sands. Some sands are very clean, i.e., almost completely free of silt and clay, while others are mixed with appreciable amounts of finer grains. A total of 5 percent silt plus clay makes a reasonable division of the sands at the family level. Two classes of Quartzipsamments are defined in terms of their silt-plus-clay content, as follows:

Coated.—The fine-earth fraction contains more than 5 percent (by weight) silt plus clay.

Uncoated.—The fine-earth fraction contains 5 percent or less (by weight) silt plus clay.

Classes of permanent cracks

Hydraquents consolidate or shrink after drainage and become Fluvaquents. In the process they form polyhedrons roughly 12 to 50 cm in diameter, depending on their *n* value and particle size. These polyhedrons are separated by cracks that range in width from 2 mm to more than 1 cm. The polyhedrons may shrink and swell with changes in the moisture content of the soil, but the cracks are permanent and can persist for several hundreds of years even though the soils are cultivated. These cracks permit rapid movement of water through the soil, either vertically or laterally. But such soils may have the same particle size, mineralogy, and other family properties as soils which are not cracked or which have cracks that open and close with the seasons. Soils with permanent cracks are very rare in the United States. They are identified by the following term:

Cracked.—This modifier is used only for families of Fluvaquents. It means that there are continuous, permanent lateral and vertical cracks 2 mm or more wide, spaced at average lateral intervals of less than 50 cm. If the family name of a Fluvaquent does not contain the modifier *cracked*, permanent cracks are assumed to be absent.

1. Saturation with water for more than 6 months per year (or artificial drainage);

2. Two percent or more (by weight) iron concretions with lateral dimensions ranging from less than 5 mm to more than 100 mm, containing 10 percent or more (by weight) free iron oxide (7 percent or more Fe) and 1 percent or more (by weight) organic matter; and

3. A reddish brown, dark reddish brown, or similar color which changes little on drying.

If *ferrihumic* is used as a modifier in the technical name of a Histosol family, no other mineralogy modifier is used for that family because the presence of iron is considered to be by far its most important mineralogical characteristic.

Modifiers applied only to terric subgroups.—In families within terric subgroups of Histosols, the same mineralogy modifiers that are used for mineral soils are applied to those mineral parts of the soil for which a particle-size modifier has been used, unless the mineralogy is ferrihumic.

Modifiers applied to limnic subgroups.—If limnic materials with a thickness of 5 cm or more are present in the control section of Histosol families, and if they do not have ferrihumic mineralogy, the following family modifiers are used:

Coprogenous. The limnic materials consist of coprogenous earth.

Diatomaceous. The limnic materials consist of diatomaceous earth.

Marly. The limnic materials consist of marl.

Reaction classes

The following two modifiers indicating reaction are used in families of all subgroups of Histosols:

Euic.—The pH value of undried samples is 4.5 or more (in 0.01 M $CaCl_2$) in one or more layers of organic soil materials within the control section.

Dysic.—The pH value of undried samples is less than 4.5 (in 0.01 M $CaCl_2$) in all layers of organic soil materials within the control section.

Soil temperature classes

The soil temperature classes of Histosol families have the same names and definitions as those used for families of mineral soils. The modifier *frigid*, however, would be redundant in the family names of boric and cryic great groups and is therefore omitted. No temperature modifier is used for families of pergelic subgroups.

Soil depth classes

The following two soil depth modifiers are used for families in all lithic subgroups of Histosols, except in the suborder of Folists:

Shallow.—Indicates a lithic contact between 18 and 50 cm from the soil surface.

Micro.—Indicates a lithic contact at a depth of less than 18 cm from the soil surface.

SERIES DIFFERENTIAE WITHIN A FAMILY

Control sections for the soil series are very similar to those for the family, but they differ in a few important respects. The particle-size and mineralogy control sections for families end at the upper boundary of a fragipan, duripan, or petrocalcic horizon because these horizons contain few roots, and in contrast to the control sections for the series, those for the family do not take into account the thickness of such horizons, or a lithic or paralithic contact between 50 and 100 cm from the mineral soil surface. The function of the series is pragmatic, and differences within a family that affect the use of a soil should be considered in classifying soil series Separations of soils at the series level can be based on differences in particle size, texture, mineralogy, amount of organic matter, structure, etc. that have not been recognized as family differentiae.

Primary attention at the series level is given to the nature of the soil within the control section, especially to genetic horizons, provided that they are well expressed and not thin. If the genetic horizons are thin or not well expressed, attention is centered on a corresponding part of the regolith. Differences in soil or regolith which are outside the control section and have not been recognized as differentiae in categories higher than the series, but which are relevant to potential uses of certain soils, are considered as a basis for phase distinctions.

Control section for the differentiation of series

Whether or not well-expressed genetic horizons are present, the part of a soil to be considered in differentiating series within a family of mineral soils is as follows:

Mineral soils with permafrost.—The series control section for soils that have permafrost within 150 cm of the soil surface extends from the soil surface to the shallowest of the following:

1. A lithic or petroferric contact; or

2. A depth of 100 cm if depth to permafrost is less than 75 cm; or

3. 25 cm below the upper boundary of permafrost if that boundary is 75 cm or more below the soil surface, or

4. 25 cm below a paralithic contact; or

5. A depth of 150 cm.

All other mineral soils.—The series control section for all other mineral soils extends from the soil surface to the shallowest of the following:

1. A lithic or petroferric contact, or

2. A depth of either 25 cm below a paralithic contact or 150 cm below the soil surface, whichever is shallower, if there is a paralithic contact within 150 cm; or

3. A depth of 150 cm if the bottom of the deepest diagnostic horizon is less than 150 cm from the soil surface; or

4. The lower boundary of the deepest diagnostic horizon or a depth of 200 cm, whichever is shallower, if the lower boundary of the deepest diagnostic horizon is 150 cm or more below the soil surface.

Organic soils (Histosols).—The series control section for Histosols normally consists of the surface, subsurface, and bottom tiers, with the same exceptions with respect to the lower boundary of the control section as defined above for the higher categories of Histosols.

TABLE 1.—KEY TO MINERALOGY CLASSES[1]

(except for Oxisols - see Table 2)

A. MINERALOGY CLASSES OF SOIL FAMILIES IN ANY PARTICLE-SIZE CLASS

Carbonatic: More than 40 percent (by weight) carbonates (expressed as $CaCO_3$) plus gypsum, with carbonates constituting more than 65 percent of the total weight of carbonates plus gypsum, either in the fine-earth fraction or in the less-than-20-mm fraction, whichever has a higher percentage of carbonates plus gypsum.

Ferritic: More than 40 percent (by weight) iron oxide (extractable by dithionite citrate), reported as Fe_2O_3 (or 28 percent reported as Fe), in the fine-earth fraction.

Gibbsitic: More than 40 percent (by weight) hydrated aluminum oxides, reported as gibbsite and bohemite, in the fine-earth fraction.

Oxidic: In the 0.02-to-2.0-mm fraction, less than 90 percent quartz and less than 40 percent of any other single kind of mineral listed below; in the fine-earth fraction, a ratio of extractable-iron-oxide plus gibbsite percentages to the clay percentage[2] that is 0.20 or more:

$$\frac{\text{extractable } Fe_2O_3 \text{ (pct.)} + \text{gibbsite (pct.)}}{\text{clay (pct.)}} \geq 0.2$$

Serpentinitic: More than 40 percent (by weight) serpentine minerals (antigorite, chrysotile, fibrolite, and talc) in the fine-earth fraction.

Gypsic: More than 40 percent (by weight) carbonates (expressed as $CaCO_3$) plus gypsum, with gypsum constituting more than 35 percent of the total weight of carbonates plus gypsum, either in the fine-earth fraction or in the less-than-20-mm fraction, whichever has a higher percentage of carbonates plus gypsum.

Glauconitic: More than 40 percent (by weight) glauconite in the fine-earth fraction.

---

[1] This key, like the others in Soil Taxonomy, is designed in such a way that the reader makes the correct classification by going through the key systematically, starting at the beginning and eliminating one by one any classes which include criteria that do not fit the soil in question. The soil belongs into the first class listed for which it meets the criteria. In the case of Table 1, the user should first go through all the items in section A and, if the soil in question does not meet the criteria for any class listed there, proceed either to section B or to section C, depending on the particle-size class of the soil.

[2] If the ratio of (percent water retained at 1500 kPa tension minus percent organic carbon) to the percentage of measured clay is 0.6 or more in half or more of the control section, then the percentage of clay is considered to be 2.5 times (percent water retained at 1500 kPa tension minus percent organic carbon), but no more than 100.

B. OTHER MINERALOGY CLASSES OF SOIL FAMILIES, IN THE FRAGMENTAL, SANDY, SANDY-SKELETAL, LOAMY, OR LOAMY-SKELETAL PARTICLE-SIZE CLASSES

Micaceous: More than 40 percent (by weight)[3] mica in the 0.02-to-20-mm fraction.

Siliceous: More than 90 percent (by weight)[4] silica minerals (quartz, chalcedony, or opal) and other extremely durable minerals that are resistant to weathering, in the 0.02-to-20-mm fraction.

Mixed: All others that have less than 40 percent (by weight) of any single kind of mineral other than quartz or feldspars, in the 0.02-to-20-mm fraction.

C. OTHER MINERALOGY CLASSES OF SOIL FAMILIES, IN THE CLAYEY OR CLAYEY-SKELETAL PARTICLE-SIZE CLASS

Halloysitic: More than one half (by weight) halloysite[5], and smaller amounts of allophane or kaolinite, or both, in the less-than-0.002-mm fraction.

Kaolinitic: More than one half (by weight) kaolinite, tabular halloysite, dickite, and nacrite, smaller amounts of other 1:1 or non-expanding 2:1 layer minerals or gibbsite, and less than 10 percent (by weight) montmorillonite, in the less-than-0.002-mm fraction.

Montmorillonitic: More than one half (by weight) montmorillonite and nontronite, or a mixture that contains more montmorillonite than any other single kind of clay mineral, in the less-than-0.002-mm fraction.

Illitic: More than one half (by weight) illite (hydrous mica), and commonly more than 4 percent K_2O, in the less-than-0.002-mm fraction.

Vermiculitic: More than one half (by weight) vermiculite, or more vermiculite than any other single kind of clay mineral, in the less-than-0.002-mm fraction.

Chloritic: More than one half (by weight) chlorite, or more chlorite than any other single kind of clay mineral, in the less-than-0.002-mm fraction.

Mixed: Other soils[6].

---

[3] Percentages by weight are estimated from grain counts. Usually, counting one or two of the dominant grain-size fractions of a conventional mechanical analysis is sufficient for placement of the soil.

[4] See preceding footnote.

[5] The halloysite considered here includes only the tubular forms. What is known as tabular halloysite is grouped with kaolinite

[6] *Sepiolitic*, defined as containing more than one half (by weight) sepiolite, attapulgite, and palygorskite, should be listed separately if identified.

TABLE 2.—KEY TO MINERALOGY CLASSES OF OXISOLS

Does the mineralogy control section have:

1. More than 40 percent iron oxide (more than 28 percent Fe) (by dithionite citrate) in the fine-earth fraction?

2. More than 40 percent gibbsite in the fine-earth fraction?

3. 18 to 40 percent iron oxide (12.6 to 28 percent Fe) (by dithionite citrate) in the fine-earth fraction?

4. 18 to 40 percent gibbsite in the fine-earth fraction?

5. More than 50 percent (by weight) kaolinite in the fine-earth fraction?

6. More than 50 percent (by weight) halloysite in the fine-earth fraction?

If none of the above—*Mixed*

1 with or without *2, 4, 5, 6*—*Ferritic*

2 with or without *3, 5, 6*—*Gibbsitic*

3 with or without *5, 6*—*Ferruginous*

4 with or without *5, 6*—*Allitic*

3 and 4 with or without *5, 6*—*Sesquic*

5—*Kaolinitic*

6—*Halloysitic*

Chapter 5

Identification of the Taxonomic Class of a Soil

All the keys in Soil Taxonomy are designed in such a way that their user can determine the correct classification of a soil by going through the key systematically, starting at the beginning and eliminating one by one any classes which include criteria that do not fit the soil in question. The soil belongs into the first class listed for which it meets all the criteria.

In classifying a specific soil to the subgroup level, the user of Soil Taxonomy begins by checking through the *Key to soil orders* to determine the name of the first order which, according to the criteria listed, includes the soil in question. The next step is to go systematically through the *Key to suborders* of that particular order to identify the right suborder for the soil, i.e., the first in the list for which it meets all the criteria. The same procedure is used to find the soil's great group class in the *Key to great groups* of the identified suborder. Likewise, going through the *Key to subgroups* of that great group, the user selects as the correct subgroup name for the classified soil the name of the first taxon for which it meets all the criteria.

KEY TO SOIL ORDERS

In this key and the other keys that follow, the diagnostic horizons and the properties mentioned do not include those below any lithic, paralithic, or petroferric contact, nor the properties of buried soils except their organic carbon if of Holocene age, andic soil properties, and base saturation. Other properties of buried soils are considered in the categories of subgroup, family, and series but not in those of order, suborder, and great group. The meaning of the term "buried soil" is given in Chapter 1.

A. Soils which:

1. Do not have andic soil properties in 60 percent or more of the thickness between the soil surface and either a depth of 60 cm, or a lithic or paralithic contact or duripan if shallower; *and*

2. Have *one or more* of the following:

a. Organic soil materials that overlie fragmental materials and/or fill their interstices, and either a lithic or paralithic contact directly below the fragmental materials, or a thickness of organic plus fragmental materials totaling 40 cm or more

2. Between either the mineral soil surface, or the top of an organic layer with andic soil properties, whichever is shallower, and a lithic or paralithic contact, duripan, or petrocalcic horizon.

Andisols, p. 139

D. Other soils which have *either*:

1. An oxic horizon that has its upper boundary within 150 cm of the mineral soil surface, and no kandic horizon that has its upper boundary within that depth; *or*

2. 40 percent or more (by weight) clay in the fine-earth fraction between the mineral soil surface and a depth of 18 cm (after mixing), *and* a kandic horizon that has the weatherable-mineral properties of an oxic horizon and has its upper boundary within 100 cm of the mineral soil surface.

Oxisols, p. 413

E. Other soils which have:

1. A layer 25 cm or more thick, with an upper boundary within 100 cm of the mineral soil surface, that has *either* slickensides close enough to intersect *or* wedge-shaped aggregates which have their long axes tilted 10 to 60 degrees from the horizontal; *and*

2. A weighted average of 30 percent or more clay in the fine-earth fraction either between the mineral soil surface and a depth of 18 cm or in an Ap horizon, whichever is thicker, *and* 30 percent or more clay in the fine-earth fraction of all horizons between a depth of 18 cm and either a depth of 50 cm, or a lithic or paralithic contact, duripan, or petrocalcic horizon if shallower; *and*

3. Cracks[1] that open and close periodically.

Vertisols, p. 491

F. Other soils that have an ochric or anthropic epipedon, and *either*:

1. Do not have an argillic, a natric, or a sulfuric horizon, *but* have *either*:

a. Saturation with water within 100 cm of the mineral soil surface for 1 month or more per year in some years, and a salic horizon that has its upper boundary within 75 cm of the mineral soil surface; *or*

---

[1] A crack is a separation between gross polyhedrons. If the surface horizon is strongly self-mulching, i.e., a mass of loose granules, or if the soil is cultivated while cracks are open, the cracks may be largely filled with granular materials from the surface; but they are open in the sense that the polyhedrons are separated. A crack is regarded as open if it controls the infiltration and percolation of water in a dry clayey soil.

H. Other soils that have *both* of the following:

1. *Either*

a. A mollic epipedon; *or*

b. *Both* a surface horizon which meets all the requirements for a mollic epipedon except thickness after the soil has been mixed to a depth of 18 cm, *and* a subhorizon more than 7.5 cm thick, within the upper part of an argillic, a kandic, or a natric horizon, that meets the color, organic-carbon content, base saturation, and structure requirements of a mollic epipedon but is separated from the surface horizon by an albic horizon; *and*

2. A base saturation of 50 percent or more (by NH_4OAc) in all horizons *either* between the upper boundary of any argillic, kandic, or natric horizon and a depth of 125 cm below that boundary, *or* between the mineral soil surface and a depth of 180 cm, *or* between the mineral soil surface and a lithic or paralithic contact, whichever depth is shallowest.

Mollisols, p. 335

I. Other soils which have *either*:

1. An argillic, a kandic, or a natric horizon; *or*

2. A fragipan that has clay films 1 mm or more thick in some part.

Alfisols, p. 79

J. Other soils which have *either*:

1. *One or more* of the following:

a. A cambic horizon; *or*

b. Aquic conditions within 50 cm of the mineral soil surface for some time in most years (or artificial drainage), and permafrost; *or*

c. Within 100 cm of the mineral soil surface, the upper boundary of one or more of the following: a calcic, petrocalcic, gypsic, petrogypsic, or placic horizon or a duripan; *or*

d. Either a fragipan or an oxic horizon that has its upper boundary within 200 cm of the mineral soil surface; *or*

e. A sulfuric horizon that has its upper boundary within 150 cm of the mineral soil surface; *or*

2. No sulfidic materials within 50 cm of the mineral soil surface; *and both*:

a. In one or more horizons between 20 and 50 cm below the mineral soil surface, either an *n* value of 0.7 or less, or less than 8 percent clay in the fine-earth fraction; *and*

b. *One or both* of the following:

(1) A histic, a mollic, a plaggen, or an umbric epipedon, *or*

(2) In 50 percent or more of the layers between the mineral soil surface and a depth of 50 cm, an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more), which decreases with increasing depth below 50 cm, *and* also ground water within 100 cm of the mineral soil surface at some time during the year when the soil is not frozen in any part.

Inceptisols, p. 289

K. Other soils.

Entisols, p. 233

IAGB. Other Albaqualfs which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Albaqualfs

IAGC. Other Albaqualfs that have *both*:

1. A chroma of 3 or more in 40 percent or more of the matrix between the lower boundary of the A or Ap horizon and a depth of 75 cm from the mineral soil surface; *and*

2. An Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample), or materials between the soil surface and a depth of 18 cm which have these color values after mixing.

Udollic Albaqualfs

IAGD. Other Albaqualfs that have a chroma of 3 or more in 40 percent or more of the matrix between the lower boundary of the A or Ap horizon and a depth of 75 cm from the mineral soil surface.

Aeric Albaqualfs

IAGE. Other Albaqualfs which have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

3. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron

percentages (by ammonium oxalate) totaling 0.40 or more.

Aquandic Albaqualfs

IAGF. Other Albaqualfs that have an Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample), or materials between the soil surface and a depth of 18 cm which have these color values after mixing.

Mollic Albaqualfs

IAGG. Other Albaqualfs which have, within 100 cm of the mineral soil surface, the upper boundary of a brittle horizon 15 cm or more thick that contains either some opal coatings or 20 percent or more (by volume) durinodes.

Durorthidic Albaqualfs

IAGH. Other Albaqualfs.

Typic Albaqualfs

Duraqualfs

Duraqualfs are the Aqualfs that have a duripan below the argillic horizon. They are not known to occur in the United States. The group has been proposed for other countries, but definitions of subgroups have not been suggested.

Endoaqualfs

Key to subgroups

IAJA. Endoaqualfs which have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

3. A fine-earth fraction containing 30 percent or

percentages (by ammonium oxalate) totaling 0.40 or more.

Aquandic Endoaqualfs

IAJB. Other Endoaqualfs that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Endoaqualfs

IAJC. Other Endoaqualfs that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Endoaqualfs

IAJD. Other Endoaqualfs that have, in one or more horizons between the A or Ap horizon and a depth of 75 cm below the mineral soil surface, *one* of the following colors:

1. A hue of 7.5YR or redder in 50 percent or more of the matrix; *and*

   a. If peds are present, a chroma of 2 or more on 50 percent or more of ped exteriors, or no redox depletions with a chroma of 2 or less in ped interiors; *or*

   b. If peds are absent, a chroma of 2 or more in 50 percent or more of the matrix; *or*

2. In 50 percent or more of the matrix, a hue of 10YR or yellower *and either*

   a. Both a color value, moist, and chroma of 3 or more; *or*

   b. A chroma of 2 or more if there are no redox concentrations.

Aeric Endoaqualfs

IAJE. Other Endoaqualfs which have a mollic epipedon, or an Ap horizon that meets all the requirements for a mollic epipedon except thickness, or materials between the soil surface and a depth of 18 cm that meet these requirements after mixing.

Mollic Endoaqualfs

IAJF. Other Endoaqualfs which have an Ap horizon that meets all the requirements for an umbric epipedon except thickness, or materials between the soil surface and a depth of 18 cm that meet these requirements after mixing.

Umbric Endoaqualfs

IAJG. Other Endoaqualfs.

Typic Endoaqualfs

Epiaqualfs

Key to subgroups

IAIA. Epiaqualfs which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Epiaqualfs

IAIB. Other Epiaqualfs which have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

3. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

   a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

   b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Aquandic Epiaqualfs

IAIC. Other Epiaqualfs that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Epiaqualfs

IAID. Other Epiaqualfs that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Epiaqualfs

IAIE. Other Epiaqualfs which have:

1. An Ap horizon that meets all the requirements for an umbric epipedon except thickness, or materials between the soil surface and a depth of 18 cm that meet these requirements after mixing; *and*

2. In one or more horizons between the A or Ap horizon and a depth of 75 cm below the mineral soil surface, *one* of the following colors:

a. A hue of 7.5YR or redder in 50 percent or more of the matrix; *and*

(1) If peds are present, a chroma of 2 or more on 50 percent or more of ped exteriors, or no redox depletions with a chroma of 2 or less in ped interiors; *or*

(2) If peds are absent, a chroma of 2 or more in 50 percent or more of the matrix; *or*

b. In 50 percent or more of the matrix, a hue of 10YR or yellower *and either*

(1) Both a color value, moist, and chroma of 3 or more; *or*

(2) A chroma of 2 or more if there are no redox concentrations.

Aeric Umbric Epiaqualfs

IAIF. Other Epiaqualfs which have *both*:

1. A mollic epipedon, or an Ap horizon that meets all the requirements for a mollic epipedon except thickness, or materials between the soil surface and a depth of 18 cm that meet these requirements after mixing; *and*

2. In 50 percent or more of the matrix in one or more horizons between the A or Ap horizon and a depth of 75 cm from the mineral soil surface, chromas as follows:

a. Three or more if the mean annual soil temperature is lower than 15°C; *or*

b. If the mean annual soil temperature is 15°C or higher:

(1) Three or more if the hue is 2.5Y or redder and the color value, moist, is 6 or more; *or*

(2) Two or more if the hue is 2.5Y or redder and the color value, moist, is 5 or less; *or*

(3) Three or more if the hue is yellower than 2.5Y; *or*

c. Two or more if there are no redox concentrations.

Udollic Epiaqualfs

IAIG. Other Epiaqualfs that have, in one or more horizons between the A or Ap horizon and a depth of 75 cm below the mineral soil surface, colors as follows: *either*

1. A hue of 7.5YR or redder in 50 percent or more of the matrix; *and*

a. If peds are present, a chroma of 2 or more on 50 percent or more of ped exteriors, or no redox depletions with a chroma of 2 or less in ped interiors; *or*

b. If peds are absent, a chroma of 2 or more in 50 percent or more of the matrix; *or*

2. In 50 percent or more of the matrix, a hue of 10YR or yellower *and either*

a. Both a color value, moist, and chroma of 3 or more; *or*

b. A chroma of 2 or more if there are no redox concentrations.

Aeric Epiaqualfs

IAIH. Other Epiaqualfs which have a mollic epipedon, or an Ap horizon that meets all the requirements for a mollic epipedon except thickness, or materials between the soil surface and a depth of 18 cm that meet these requirements after mixing.

Mollic Epiaqualfs

IAII. Other Epiaqualfs which have an Ap horizon that meets all the requirements for an umbric epipedon except thickness, or materials between the soil surface and a depth of 18 cm that meet these requirements after mixing.

Umbric Epiaqualfs

IAIJ. Other Epiaqualfs.

Typic Epiaqualfs

Fragiaqualfs

Key to subgroups

IADA. Fragiaqualfs that have, between the A or Ap horizon and a fragipan, a horizon with 50 percent or more chroma of 3 or more if the hue is 10YR or redder, or of 4 or more if the hue is 2.5Y or yellower.

Aeric Fragiaqualfs

IADB. Other Fragiaqualfs that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Fragiaqualfs

Kandiaqualfs

Key to subgroups

IAEA. Kandiaqualfs that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Kandiaqualfs

IAEB. Other Kandiaqualfs that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Kandiaqualfs

IAEC. Other Kandiaqualfs that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Kandiaqualfs

IAED. Other Kandiaqualfs that have *both*:

1. An Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample), or materials between the soil surface and a depth of 18 cm which have these color values after mixing; *and*

2. In one or more horizons between the A or Ap horizon and a depth of 75 cm below the mineral soil surface, *one* of the following colors:

a. A hue of 7.5YR or redder in 50 percent or more of the matrix, *and*

(1) If peds are present, either a chroma of 2 or more on 50 percent or more of ped exteriors, or no redox depletions with a chroma of 2 or less in ped interiors; *or*

(2) If peds are absent, a chroma of 2 or more in 50 percent or more of the matrix; *or*

b. In 50 percent or more of the matrix, a hue of 10YR or yellower *and either*

(1) Both a color value, moist, and chroma of 3 or more; *or*

(2) A chroma of 2 or more if there are no redox concentrations.

Aeric Umbric Kandiaqualfs

IAEE. Other Kandiaqualfs that have, in one or more horizons between the A or Ap horizon and a depth of 75 cm below the mineral soil surface, *one* of the following colors:

1. A hue of 7.5YR or redder in 50 percent or more of the matrix, *and*

acidity, either throughout the upper 15 cm of the natric horizon, or in all horizons within 40 cm of the mineral soil surface, whichever is deeper.

Albic Natraqualfs

IACD. Other Natraqualfs that have a glossic horizon, or interfingering of albic materials into the natric horizon.

Glossic Natraqualfs

IACE. Other Natraqualfs that have an Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample), or materials between the soil surface and a depth of 18 cm which have these color values after mixing.

Mollic Natraqualfs

IACF. Other Natraqualfs.

Typic Natraqualfs

Plinthaqualfs

Plinthaqualfs are the Aqualfs that have one or more horizons between 30 and 150 cm from the mineral soil surface in which plinthite either forms a continuous phase or constitutes one half or more of the volume.

Umbraqualfs

Key to subgroups

IAHA. Umbraqualfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

3. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

   a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

   b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Aquandic Umbraqualfs

IAHB. Other Umbraqualfs that have a sandy particle size throughout a layer extending from the mineral soil

Cryoboralfs

Key to subgroups

IBDA. Cryoboralfs that have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*

2. A color value, moist, of 3 or less (crushed and smoothed sample) either in an Ap horizon, or between the soil surface and a depth of 15 cm, after mixing.

Lithic Mollic Cryoboralfs

IBDB. Other Cryoboralfs that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Cryoboralfs

IBDC. Other Cryoboralfs which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Cryoboralfs

IBDD. Other Cryoboralfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Cryoboralfs

IBDE. Other Cryoboralfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Vitrandic Cryoboralfs

IBDF. Other Cryoboralfs that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Cryoboralfs

IBDG. Other Cryoboralfs that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Cryoboralfs

IBDH. Other Cryoboralfs which have an argillic horizon that *either* has a texture of loamy fine sand or coarser, *or* is discontinuous vertically in its upper 15 cm (in lamellae).

Psammentic Cryoboralfs

IBDI. Other Cryoboralfs that have a color value, moist, of 3 or less (crushed and smoothed sample) either in an Ap horizon, or between the soil surface and a depth of 15 cm, after mixing.

Mollic Cryoboralfs

IBDJ. Other Cryoboralfs that have a glossic horizon.

Glossic Cryoboralfs

IBDK. Other Cryoboralfs.

Typic Cryoboralfs

Eutroboralfs

Key to subgroups

IBEA. Eutroboralfs that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Eutroboralfs

IBEB. Other Eutroboralfs which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Vitrandic Glossoboralfs

IBFD. Other Glossoboralfs that have, in one or more subhorizons within the upper 25 cm of the argillic horizon, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Glossoboralfs

IBFE. Other Glossoboralfs that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Glossoboralfs

IBFF. Other Glossoboralfs which have an argillic horizon that *either* has a texture of loamy fine sand or coarser, *or* is discontinuous vertically in its upper 15 cm (in lamellae).

Psammentic Glossoboralfs

IBFG. Other Glossoboralfs that do not have a glossic horizon.

Eutric Glossoboralfs

IBFH. Other Glossoboralfs.

Typic Glossoboralfs

Natriboralfs

Natriboralfs are the Boralfs that have a natric horizon. They are rare in the United States, and subgroups have not been developed.

Paleboralfs

Key to subgroups

IBAA. Paleboralfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Paleboralfs

IBAB. Other Paleboralfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

    a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

    b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Vitrandic Paleboralfs

IBAC. Other Paleboralfs that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Paleboralfs

IBAD. Other Paleboralfs that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Paleboralfs

IBAE. Other Paleboralfs which have an argillic horizon that has, in its fine-earth fraction, a clay increase with depth of 20 percent or more (absolute) within its upper 7.5 cm.

Abruptic Paleboralfs

IBAF. Other Paleboralfs that have an Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample), or materials between the soil surface and a depth of 18 cm which have these color values after mixing.

Mollic Paleboralfs

IBAG. Other Paleboralfs.

Typic Paleboralfs

IEH. Other Udalfs that have a CEC of 16 cmol(+)/kg clay or less (by 1N NH_4OAc pH 7) and an ECEC of 12 cmol(+)/kg clay or less (sum of bases extracted with 1N NH_4OAc pH 7, plus 1N-KCl-extractable Al) in 50 percent or more *either* of the argillic or kandic horizon if less than 100 cm thick, *or* of its upper 100 cm.

Kanhapludalfs, p. 111

IEI. Other Udalfs which:

1. Do not have a lithic or paralithic contact within 150 cm of the mineral soil surface; *and*

2. Within 150 cm of the mineral soil surface, *either*

   a. Do not have a clay decrease with depth of 20 percent or more (relative) from the maximum clay content; *or*

   b. Have 5 percent or more (by volume) skeletans on faces of peds in the layer that has a 20 percent lower clay content *and*, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction; *and*

3. Have *one or more* of the following in the argillic horizon:

   a. In the matrix of its lowest subhorizon, a hue redder than 10YR and 50 percent or more chroma of 5 or more; *or*

   b. In 50 percent or more of its matrix, a hue of 2.5YR or redder, a color value, moist, of 3 or less, and a color value, dry, of 4 or less; *or*

   c. In one or more subhorizons, many coarse redox concentrations with a hue redder than 7.5YR or a chroma of 6 or more, or both.

Paleudalfs, p. 112

IEJ. Other Udalfs which have throughout the argillic horizon a hue of 2.5YR or redder, a color value, moist, of 3 or less, and a color value, dry, no more than 1 unit higher than the value, moist.

Rhodudalfs, p. 115

IEK. Other Udalfs.

Hapludalfs, p. 105

Agrudalfs

Agrudalfs are the Udalfs that have an agric horizon; some of them have an anthropic epipedon. These soils have been farmed for many hundreds of years and have received heavy applications of animal manure and other amendments. They are not known to occur in the United States. It seems probable that only the typic and anthropic subgroups are needed for this great group.

and also aquic conditions for some time in most years (or artificial drainage).

Aquic Glossudalfs

IEEF. Other Glossudalfs that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Glossudalfs

IEEG. Other Glossudalfs that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm or more.

Arenic Glossudalfs

IEEH. Other Glossudalfs that do not have a glossic horizon 50 cm or more thick.

Haplic Glossudalfs

IEEI. Other Glossudalfs.

Typic Glossudalfs

Hapludalfs

Key to subgroups

IEKA. Hapludalfs that have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*

2. In one or more subhorizons within the upper 25 cm of the argillic horizon, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Lithic Hapludalfs

IEKB. Other Hapludalfs that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Hapludalfs

IEKC. Other Hapludalfs which have *both*:

1. *One or both* of the following:

a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower; *and*

2. Redox depletions with a chroma of 2 or less in layers that also have aquic conditions in most years (or artificial drainage) *either*:

IEKG. Other Hapludalfs which have *both*:

1. Redox depletions with a chroma of 2 or less in layers that also have aquic conditions in most years (or artificial drainage) *either*:

a. Within the upper 25 cm of the argillic horizon if its upper boundary is within 50 cm of the mineral soil surface, *or*

b. Within 75 cm of the mineral soil surface if the upper boundary of the argillic horizon is 50 cm or more below the mineral soil surface; *and*

2. An argillic horizon that *either* has a texture of loamy fine sand or coarser *or* is discontinuous vertically within its upper 20 cm.

Psammaquentic Hapludalfs

IEKH. Other Hapludalfs which have an argillic horizon that *either* has a texture of loamy fine sand or coarser *or* is discontinuous vertically within its upper 20 cm.

Psammentic Hapludalfs

IEKI. Other Hapludalfs that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. A sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm or more.

Aquic Arenic Hapludalfs

IEKJ. Other Hapludalfs that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm or more.

Arenic Hapludalfs

IEKK. Other Hapludalfs that have anthraquic conditions.

Anthraquic Hapludalfs

IEKL. Other Hapludalfs which have:

1. An abrupt textural change; *and*

2. Redox depletions with a chroma of 2 or less in layers that also have aquic conditions in most years (or artificial drainage) *either*:

a. Within the upper 25 cm of the argillic horizon if its upper boundary is within 50 cm of the mineral soil surface, *or*

b. Within 75 cm of the mineral soil surface if the upper boundary of the argillic horizon is 50 cm or more below the mineral soil surface; *and*

3. A base saturation (by sum of cations) of less than 60 percent at a depth of 125 cm from the top of the argillic horizon, or at a depth of 180 cm from the mineral soil surface, or directly above a lithic or paralithic contact, whichever is shallowest.

Albaquultic Hapludalfs

IEKM. Other Hapludalfs which have *both*:

1. An abrupt textural change; *and*

2. Redox depletions with a chroma of 2 or less in layers that also have aquic conditions in most years (or artificial drainage) *either*:

a. Within the upper 25 cm of the argillic horizon if its upper boundary is within 50 cm of the mineral soil surface, *or*

b. Within 75 cm of the mineral soil surface if the upper boundary of the argillic horizon is 50 cm or more below the mineral soil surface.

Albaquic Hapludalfs

IEKN. Other Hapludalfs which have *both*:

1. Interfingering of albic materials, and albic materials surrounding some peds, in the upper part of the argillic horizon; *and*

2. Redox depletions with a chroma of 2 or less in layers that also have aquic conditions in most years (or artificial drainage) *either*:

a. Within the upper 25 cm of the argillic horizon if its upper boundary is within 50 cm of the mineral soil surface, *or*

b. Within 75 cm of the mineral soil surface if the upper boundary of the argillic horizon is 50 cm or more below the mineral soil surface.

Glossaquic Hapludalfs

IEKO. Other Hapludalfs which have *both*:

1. Redox depletions with a chroma of 2 or less in layers that also have aquic conditions in most years (or artificial drainage) *either*:

a. Within the upper 25 cm of the argillic horizon if its upper boundary is within 50 cm of the mineral soil surface, *or*

b. Within 75 cm of the mineral soil surface if the upper boundary of the argillic horizon is 50 cm or more below the mineral soil surface; *and*

2. A base saturation (by sum of cations) of less than 60 percent at a depth of 125 cm from the top of the argillic horizon, or at a depth of 180 cm

IEGE. Other Kandiudalfs that have *both*:

1. A sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more; *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Grossarenic Plinthic Kandiudalfs

IEGF. Other Kandiudalfs that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Kandiudalfs

IEGG. Other Kandiudalfs that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Kandiudalfs

IEGH. Other Kandiudalfs that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Kandiudalfs

IEGI. Other Kandiudalfs that have, throughout the argillic or kandic horizon, a hue of 2.5YR or redder, a color value, moist, of 3 or less, and a color value, dry, that is no more than one unit higher than the value, moist.

Rhodic Kandiudalfs

IEGJ. Other Kandiudalfs that have an Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample), or materials between the soil surface and a depth of 18 cm which have these color values after mixing.

Mollic Kandiudalfs

IEGK. Other Kandiudalfs.

Typic Kandiudalfs

Kanhapludalfs

<u>Key to subgroups</u>

IEHA. Kanhapludalfs that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Kanhapludalfs

IEHB. Other Kanhapludalfs that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Kanhapludalfs

IEIO. Other Paleudalfs that have, throughout the argillic horizon, a hue of 2.5YR or redder, a color value, moist, of 3 or less, and a color value, dry, that is no more than one unit higher than the value, moist.

Rhodic Paleudalfs

IEIP. Other Paleudalfs that have an Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample), or materials between the soil surface and a depth of 18 cm which have these color values after mixing.

Mollic Paleudalfs

IEIQ. Other Paleudalfs.

Typic Paleudalfs

Rhodudalfs

Rhodudalfs are dark red Udalfs that have a thinner solum than Paleudalfs. Their definition is parallel to that of other Rhodic great groups. Their parent materials are basic. These soils are rare in the United States, and definitions of subgroups have not been developed.

USTALFS

Key to great groups

ICA. Ustalfs which have a duripan that has its upper boundary within 100 cm of the mineral soil surface.

Durustalfs, p. 117

ICB. Other Ustalfs that have one or more horizons within 150 cm of the mineral soil surface in which plinthite either forms a continuous phase or constitutes one half or more of the volume.

Plinthustalfs, p. 128

ICC. Other Ustalfs that have a natric horizon.

Natrustalfs, p. 123

ICD. Other Ustalfs which:

1. Have a CEC of 16 cmol(+)/kg clay or less (by 1N NH_4OAc pH 7) and an ECEC of 12 cmol(+)/kg clay or less (sum of bases extracted with 1N NH_4OAc pH 7, plus 1N-KCl-extractable Al) in 50 percent or more *either* of the argillic or kandic horizon if less than 100 cm thick, *or* of its upper 100 cm; *and*

2. Do not have a lithic, paralithic, or petroferric contact within 150 cm of the mineral soil surface; *and*

3. Within 150 cm of the mineral soil surface, *either*

    a. Do not have a clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content; *or*

b. Have 5 percent or more (by volume) skeletans on faces of peds in the layer that has a 20 percent lower clay content *and*, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction.
Kandiustalfs, p. 120

ICE. Other Ustalfs that have a CEC of 16 cmol(+)/kg clay or less (by 1N NH_4OAc pH 7) and an ECEC of 12 cmol(+)/kg clay or less (sum of bases extracted with 1N NH_4OAc pH 7, plus 1N-KCl-extractable Al) in 50 percent or more *either* of the argillic or kandic horizon if less than 100 cm thick, *or* of its upper 100 cm.
Kanhaplustalfs, p. 122

ICF. Other Ustalfs which have *one or more* of the following:

1. A petrocalcic horizon that has its upper boundary within 150 cm of tne mineral soil surface; *or*

2. No lithic or paralithic contact within 150 cm of the mineral soil surface, *and* an argillic horizon which has *both*:

a. Within 150 cm of the mineral soil surface, *either*

(1) No clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content; *or*

(2) Five percent or more (by volume) skeletans on faces of peds in the layer that has a 20 percent lower clay content *and*, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction; *and*

b. *One or more* of the following:

(1) In the matrix of its lowest subhorizon, a hue of 7.5YR or redder and a chroma of 5 or more; *or*

(2) In 50 percent or more of its matrix, a hue of 7.5YR or redder, a color value, moist, or 3 or less, and a çolor value, dry, of 4 or less; *or*

(3) In the matrix of its lowest subhorizon, common or many coarse redox concentrations with a hue of 7.5YR or redder or a chroma of 6 or more, or both; *or*

3. No lithic or paralithic contact within 50 cm of the mineral soil surface, *and* an argillic horizon which has *both*:

a. A clayey particle size throughout one or more subhorizons in its upper part; *and*

b. At its upper boundary, a clay increase of *either* 20 percent or more (absolute) within a vertical distance of 7.5 cm, *or* of 15 percent or more (absolute) within a vertical distance of 2.5 cm, in the fine-earth fraction.
Paleustalfs, p. 124

ICG. Other Ustalfs which have throughout the argillic horizon a hue of 2.5YR or redder, a color value, moist, of 3 or less, and a color value, dry, no more than 1 unit higher than the value, moist.
Rhodustalfs, p. 128

ICH. Other Ustalfs.
Haplustalfs, p. 117

Durustalfs

Durustalfs are the Ustalfs which have a duripan that has its upper boundary within 100 cm of the mineral soil surface. They are not known to occur in the United States, but the great group has been provided for use in other countries. Subgroups have not been developed.

Haplustalfs

Key to subgroups

ICHA. Haplustalfs that have a lithic contact within 50 cm of the mineral soil surface.
Lithic Haplustalfs

ICHB. Other Haplustalfs which have *both*:

1. If neither irrigated nor fallowed to store moisture, *either*:

a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for four tenths or less of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C; *and*

2. *One or both* of the following:

a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Udertic Haplustalfs

ICHC. Other Haplustalfs which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Haplustalfs

ICHD. Other Haplustalfs that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. A sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Aquic Arenic Haplustalfs

ICHE. Other Haplustalfs that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. An argillic horizon that has a base saturation (by sum of cations) of less than 75 percent throughout.

Aquultic Haplustalfs

ICHF. Other Haplustalfs that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic

remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Aridic Haplustalfs

ICHL. Other Haplustalfs that have a CEC of less than 24 cmol(+)/kg clay (by 1N NH_4OAc pH 7) in 50 percent or more *either* of the argillic horizon if less than 100 cm thick, *or* of its upper 100 cm.

Kanhaplic Haplustalfs

ICHM. Other Haplustalfs that have an argillic horizon with a base saturation (by sum of cations) of less than 75 percent throughout.

Ultic Haplustalfs

ICHN. Other Haplustalfs which, if neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in some part for four tenths or less of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Udic Haplustalfs

ICHO. Other Haplustalfs.

Typic Haplustalfs

Kandiustalfs

Key to subgroups

ICDA. Kandiustalfs that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Kandiustalfs

ICDB. Other Kandiustalfs that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. A sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Aquic Arenic Kandiustalfs

ICDC. Other Kandiustalfs that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Kandiustalfs

ICDD. Other Kandiustalfs that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Kandiustalfs

ICDE. Other Kandiustalfs which have *both*:

1. A sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm; *and*

2. If neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Arenic Aridic Kandiustalfs

ICDF. Other Kandiustalfs that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Kandiustalfs

ICDG. Other Kandiustalfs which, if neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at

a depth of 50 cm below the soil surface is higher than 8°C.

Aridic Kandiustalfs

ICDH. Other Kandiustalfs which, if neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in some part for 135 cumulative days or less per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Udic Kandiustalfs

ICDI. Other Kandiustalfs which have, throughout the argillic or kandic horizon, a hue of 2.5YR or redder, a color value, moist, of 3 or less, and a color value, dry, that is no more than one unit higher than the value, moist.

Rhodic Kandiustalfs

ICDJ. Other Kandiustalfs.

Typic Kandiustalfs

Kanhaplustalfs

Key to subgroups

ICEA. Kanhaplustalfs that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Kanhaplustalfs

ICEB. Other Kanhaplustalfs that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Kanhaplustalfs

ICEC. Other Kanhaplustalfs which, if neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90

b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C; *and*

2. *One or both* of the following:

a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Udertic Paleustalfs

ICFB. Other Paleustalfs which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Paleustalfs

ICFC. Other Paleustalfs which have an argillic horizon that has a texture of loamy fine sand or coarser, *or* is discontinuous horizontally, *or* is discontinuous vertically within its upper 20 cm.

Psammentic Paleustalfs

ICFD. Other Paleustalfs that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Paleustalfs

ICFE. Other Paleustalfs that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. A sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Aquic Arenic Paleustalfs

ICFF. Other Paleustalfs that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Paleustalfs

ICFG. Other Paleustalfs that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Paleustalfs

ICFH. Other Paleustalfs that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Paleustalfs

ICFI. Other Paleustalfs which have a petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface.

Petrocalcic Paleustalfs

ICFJ. Other Paleustalfs which have *both*:

1. A sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm; *and*

2. If neither irrigated nor fallowed to store moisture, *either*:

a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Arenic Aridic Paleustalfs

ICFK. Other Paleustalfs that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Paleustalfs

ICFP. Other Paleustalfs that have an argillic horizon with a base saturation (by sum of cations) of less than 75 percent throughout.

Ultic Paleustalfs

ICFQ. Other Paleustalfs which, if neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in some part for four tenths or less of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Udic Paleustalfs

ICFR. Other Paleustalfs.

Typic Paleustalfs

Plinthustalfs

Plinthustalfs are the Ustalfs that have one or more horizons within 150 cm of the mineral soil surface in which plinthite either forms a continuous phase or constitutes one half or more of the volume. There are no soil series in the United States that are presently classified in this great group, but the group is provided for other parts of the world. Subgroups have not been developed.

Rhodustalfs

Key to subgroups

ICGA. Rhodustalfs that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Rhodustalfs

ICGB. Other Rhodustalfs that have a CEC of less than 24 cmol(+) per kg clay (by 1N NH_4OAc pH 7) in 50 percent or more *either* of the argillic horizon if less than 100 cm thick, *or* of its upper 100 cm.

Kanhaplic Rhodustalfs

ICGC. Other Rhodustalfs which, if neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for four tenths or less of the cumulative days per year when the

temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Udic Rhodustalfs

ICGD. Other Rhodustalfs.

Typic Rhodustalfs

XERALFS

Key to great groups

IDA. Xeralfs which have a duripan that has its upper boundary within 100 cm of the mineral soil surface.

Durixeralfs, p. 130

IDB. Other Xeralfs that have a natric horizon.

Natrixeralfs, p. 135

IDC. Other Xeralfs that have a fragipan.

Fragixeralfs, p. 131

IDD. Other Xeralfs that have one or more horizons within 150 cm of the mineral soil surface in which plinthite either forms a continuous phase or constitutes one half or more of the volume.

Plinthoxeralfs, p. 138

IDE. Other Xeralfs which have throughout the argillic horizon a hue of 2.5YR or redder, a color value, moist, of 3 or less, and a color value, dry, no more than 1 unit higher than the value, moist.

Rhodoxeralfs, p. 138

IDF. Other Xeralfs which have *one or more* of the following:

1. A petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface; *or*

2. No lithic or paralithic contact within 150 cm of the mineral soil surface, and an argillic horizon which has *both*:

a. Within 150 cm of the mineral soil surface, *either*

(1) No clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content; *or*

(2) Five percent or more (by volume) skeletans on faces of peds in the layer that has a 20 percent lower clay content *and*, below that layer, a clay increase of 3 percent or more

more (absolute) within a vertical distance of 7.5 cm, *or* of 15 percent or more (absolute) within a vertical distance of 2.5 cm, in the fine-earth fraction; *and*

2. A duripan that is not indurated in any subhorizon.

Abruptic Haplic Durixeralfs

IDAE. Other Durixeralfs which have an argillic horizon that has *both*:

1. A clayey particle size throughout some subhorizon 7.5 cm or more thick; *and*

2. At its upper boundary or within some part, a clay increase *either* of 20 percent or more (absolute) within a vertical distance of 7.5 cm, *or* of 15 percent or more (absolute) within a vertical distance of 2.5 cm, in the fine-earth fraction.

Abruptic Durixeralfs

IDAF. Other Durixeralfs which have a duripan that is not indurated in any subhorizon.

Haplic Durixeralfs

IDAG. Other Durixeralfs.

Typic Durixeralfs

Fragixeralfs

Key to subgroups

IDCA. Fragixeralfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Fragixeralfs

IDCB. Other Fragixeralfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron

its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Haploxeralfs

IDGE. Other Haploxeralfs which have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

a. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

b. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

c. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

(1) In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

(2) In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Aquandic Haploxeralfs

IDGF. Other Haploxeralfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Haploxeralfs

IDGG. Other Haploxeralfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66

percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Vitrandic Haploxeralfs

IDGH. Other Haploxeralfs which have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. An argillic horizon that has a base saturation (by sum of cations) of less than 75 percent in one or more subhorizons within its upper 75 cm or above a lithic or paralithic contact, whichever is shallower.

Aquultic Haploxeralfs

IDGI. Other Haploxeralfs that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Haploxeralfs

IDGJ. Other Haploxeralfs that have an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) in one or more subhorizons of the argillic horizon.

Natric Haploxeralfs

IDGK. Other Haploxeralfs which have an argillic horizon that is *either* discontinuous vertically within its upper 20 cm, *or* has a sandy particle size.

Psammentic Haploxeralfs

IDGL. Other Haploxeralfs that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Haploxeralfs

IDGM. Other Haploxeralfs which have a calcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Calcic Haploxeralfs

IDGN. Other Haploxeralfs which have an argillic horizon that has a base saturation (by sum of cations) of less than 75 percent in one or more subhorizons within its upper 75 cm or above a lithic or paralithic contact, whichever is shallower.

Ultic Haploxeralfs

IDGO. Other Haploxeralfs that have a color value, moist, of 3 or less and 0.7 percent or more organic carbon, either throughout an Ap horizon or throughout the upper 10 cm of an A horizon.

Mollic Haploxeralfs

IDGP. Other Haploxeralfs.

Typic Haploxeralfs

Natrixeralfs

Key to subgroups

IDBA. Natrixeralfs which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Natrixeralfs

IDBB. Other Natrixeralfs that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Natrixeralfs

IDBC. Other Natrixeralfs.

Typic Natrixeralfs

Palexeralfs

Key to subgroups

IDFA. Palexeralfs which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Vitrandic Palexeralfs

IDFE. Other Palexeralfs that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Palexeralfs

IDFF. Other Palexeralfs which have a petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface.

Petrocalcic Palexeralfs

IDFG. Other Palexeralfs that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm or more.

Arenic Palexeralfs

IDFH. Other Palexeralfs that have an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) in one or more horizons within 100 cm of the mineral soil surface.

Natric Palexeralfs

IDFI. Other Palexeralfs that have a calcic horizon within 150 cm of the mineral soil surface.

Calcic Palexeralfs

IDFJ. Other Palexeralfs that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Palexeralfs

IDFK. Other Palexeralfs which have an argillic horizon that has a base saturation (by sum of cations) of less than 75 percent throughout.

Ultic Palexeralfs

IDFL. Other Palexeralfs with an argillic horizon that has *neither*:

1. A clayey particle size throughout any subhorizon in its upper part; *nor*

2. At its upper boundary, a clay increase of 20 percent or more (absolute) within a vertical distance of 7.5 cm, or of 15 percent or more (absolute) within a vertical distance of 2.5 cm, in the fine-earth fraction.

Haplic Palexeralfs

IDFM. Other Palexeralfs that have a color value, moist, of 3 or less and 0.7 percent or more organic carbon, either throughout an Ap horizon or throughout the upper 10 cm of an A horizon.

Mollic Palexeralfs

IDFN. Other Palexeralfs.

Typic Palexeralfs

Plinthoxeralfs

Plinthoxeralfs are the Xeralfs that have one or more horizons within 150 cm of the mineral soil surface in which plinthite either forms a continuous phase or constitutes one half or more of the volume. There are few of these soils in the United States, but they are moderately extensive in other parts of the world. Subgroups have not been developed.

Rhodoxeralfs

Key to subgroups

IDEA. Rhodoxeralfs that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Rhodoxeralfs

IDEB. Other Rhodoxeralfs which have a petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface.

Petrocalcic Rhodoxeralfs

IDEC. Other Rhodoxeralfs which have a calcic horizon that has its upper boundary within 150 cm of the mineral soil surface.

Calcic Rhodoxeralfs

IDED. Other Rhodoxeralfs which have an argillic horizon that is either less than 15 cm thick or is discontinuous horizontally in each pedon.

Ochreptic Rhodoxeralfs

IDEE. Other Rhodoxeralfs.

Typic Rhodoxeralfs

Chapter 7

Andisols[1]

KEY TO SUBORDERS

CA. Andisols that have *either*:

1. A histic epipedon; *or*

2. In a layer between 40 and 50 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

a. Two percent or more redox concentrations; *or*

b. A color value, moist, of 4 or more, and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds, or in the matrix if peds are absent; *or*

c. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquands, p. 140

CB. Other Andisols that have a cryic or pergelic soil temperature regime.

Cryands, p. 146

CC. Other Andisols that have an aridic moisture regime.

Torrands, p. 150

CD. Other Andisols that have a xeric moisture regime.

Xerands, p. 174

CE. Other Andisols that have a 1500-kPa water retention of less than 15 percent on air-dried samples *and* of less than 30 percent on undried samples, throughout one or more horizons with a total thickness of 35 cm or more within 60 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Vitrands, p. 172

CF. Other Andisols that have an ustic moisture regime.

Ustands, p. 169

CG. Other Andisols.

Udands, p. 151

[1] This chapter builds on the preliminary Andisol Proposal (1978) by Guy D. Smith (NZ Soil Bureau Record 96) and represents the work of the International Committee on the Classification of Andisols (ICOMAND), chaired by Michael L. Leamy, New Zealand Soil Bureau.

AQUANDS

Key to great groups

CAA. Aquands that have a cryic or pergelic soil temperature regime.

Cryaquands, p. 140

CAB. Other Aquands that have, in half or more of each pedon, a placic horizon within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Placaquands, p. 144

CAC. Other Aquands that have, in 75 percent or more of each pedon, a cemented layer which does not slake in water after air-drying and which has its upper boundary within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Duraquands, p. 141

CAD. Other Aquands that have a 1500-kPa water retention of less than 15 percent on air-dried samples *and* of less than 30 percent on undried samples, throughout one or more horizons with a total thickness of 35 cm or more within 60 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Vitraquands, p. 145

CAE. Other Aquands that have a melanic epipedon.

Melanaquands, p. 143

CAF. Other Aquands that have episaturation.

Epiaquands, p. 142

CAG. Other Aquands.

Endoaquands, p. 141

Cryaquands

Key to subgroups

CAAA. Cryaquands that have a lithic contact within 50 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Cryaquands

CAAB. Other Cryaquands that have a mean annual soil temperature of 0°C or lower.

Pergelic Cryaquands

CAAC. Other Cryaquands that have a histic epipedon.

Histic Cryaquands

CAAD. Other Cryaquands that have, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Cryaquands

CAAE. Other Cryaquands.

Typic Cryaquands

Duraquands

Key to subgroups

CACA. Duraquands that have a histic epipedon.

Histic Duraquands

CACB. Other Duraquands that have extractable bases plus 1N-KCl-extractable Al^{3+} totaling less than 2.0 cmol(+)/kg in the fine-earth fraction of one or more horizons with a total thickness of 30 cm or more, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower.

Acraquoxic Duraquands

CACC. Other Duraquands that have, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Duraquands

CACD. Other Duraquands.

Typic Duraquands

Endoaquands

Key to subgroups

CAGA. Endoaquands that have a lithic contact within 50 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Endoaquands

CAGB. Other Endoaquands that have a petroferric contact within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Petroferric Endoaquands

CAGC. Other Endoaquands which have a horizon 15 cm or more thick, with 20 percent or more (by volume) cemented soil material that does not slake in water after air-drying, that has its upper boundary within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Duric Endoaquands

CAGD. Other Endoaquands that have a histic epipedon.

Histic Endoaquands

CAGE. Other Endoaquands that have more than 2.0 cmol(+)/kg Al^{3+} (by 1N KCl) in the fine-earth fraction of one or more horizons with a total thickness of 10 cm or more, between 25 and 50 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower.

Alic Endoaquands

CAGF. Other Endoaquands that have, undried, a 1500-kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Hydric Endoaquands

CAGG. Other Endoaquands that have, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Endoaquands

CAGH. Other Endoaquands.

Typic Endoaquands

Epiaquands

Key to subgroups

CAFA. Other Epiaquands that have a petroferric contact within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Petroferric Epiaquands

CAFB. Other Epiaquands that have a horizon 15 cm or more thick, with 20 percent or more (by volume) cemented soil material that does not slake in water after air-drying, that has its upper boundary within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Duric Epiaquands

CAFC. Other Epiaquands that have a histic epipedon.
Histic Epiaquands

CAFD. Other Epiaquands that have more than 2.0 cmol(+)/kg Al^{3+} (by 1N KCl) in the fine-earth fraction of one or more horizons with a total thickness of 10 cm or more, between 25 and 50 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower.
Alic Epiaquands

CAFE. Other Epiaquands that have, undried, a 1500-kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.
Hydric Epiaquands

CAFF. Other Epiaquands that have, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.
Thaptic Epiaquands

CAFG. Other Epiaquands.
Typic Epiaquands

Melanaquands

Key to subgroups

CAEA. Melanaquands that have a lithic contact within 50 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.
Lithic Melanaquands

CAEB. Other Melanaquands that have extractable bases plus 1N-KCl-extractable Al^{3+} totaling less than 2.0 cmol(+)/kg in the fine-earth fraction of one or more horizons with a total thickness of 30 cm or more, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower.
Acraquoxic Melanaquands

CAEC. Other Melanaquands that have *both*:

1. Undried, a 1500-kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. More than 6.0 percent organic carbon and colors of a mollic epipedon throughout a layer 50 cm or more thick within 60 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Hydric Pachic Melanaquands

CAED. Other Melanaquands that have, undried, a 1500-kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Hydric Melanaquands

CAEE. Other Melanaquands that have, between 40 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Melanaquands

CAEF. Other Melanaquands.

Typic Melanaquands

Placaquands

Key to subgroups

CABA. Placaquands that have a lithic contact within 50 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Placaquands

CABB. Other Placaquands which have *both*:

1. A histic epipedon; *and*

2. A horizon 15 cm or more thick, with 20 percent or more (by volume) cemented soil material that does not slake in water after air-drying, that has its upper boundary within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Duric Histic Placaquands

CABC. Other Placaquands which have a horizon 15 cm or more thick, with 20 percent or more (by volume) cemented soil material that does not slake in water after air-drying, that has its upper boundary within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Duric Placaquands

CABD. Other Placaquands that have a histic epipedon.

Histic Placaquands

CABE. Other Placaquands that have, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Placaquands

CABF. Other Placaquands.

Typic Placaquands

Vitraquands

Key to subgroups

CADA. Vitraquands that have a lithic contact within 50 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Vitraquands

CADB. Other Vitraquands which have a horizon 15 cm or more thick, with 20 percent or more (by volume) cemented soil material that does not slake in water after air-drying, that has its upper boundary within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Duric Vitraquands

CADC. Other Vitraquands that have a histic epipedon.

Histic Vitraquands

CADD. Other Vitraquands that have, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Vitraquands

CADE. Other Vitraquands.

Typic Vitraquands

CRYANDS

Key to great groups

CBA. Cryands that have a mean annual soil temperature of 0°C or lower.

Gelicryands, p. 147

CBB. Other Cryands that have a melanic epipedon.

Melanocryands, p. 149

CBC. Other Cryands which have an epipedon with a color value, moist, and chroma of 3 or less that meets the depth, thickness, and organic-carbon requirements for a melanic epipedon.

Fulvicryands, p. 146

CBD. Other Cryands that have, undried, a 1500-kPa water retention of 100 percent or more throughout one or more layers with a total thickness of 35 cm or more within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Hydrocryands, p. 148

CBE. Other Cryands that have a 1500-kPa water retention of less than 15 percent on air-dried samples *and* of less than 30 percent on undried samples, throughout one or more horizons with a total thickness of 35 cm or more within 60 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Vitricryands, p. 149

CBF. Other Cryands.

Haplocryands, p. 147

Fulvicryands

Key to subgroups

CBCA. Fulvicryands that have a lithic contact within 50 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Fulvicryands

CBCB. Other Fulvicryands which have, undried, a 1500-kPa water retention of less than 30 percent throughout one or more layers with andic soil properties that have a total thickness of 25 cm more within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Vitric Fulvicryands

CBCC. Other Fulvicryands.

Typic Fulvicryands

Gelicryands

Key to subgroups

CBAA. All Gelicryands.

Typic Gelicryands

Haplocryands

Key to subgroups

CBFA. Haplocryands that have a lithic contact within 50 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Haplocryands

CBFB. Other Haplocryands that have more than 2.0 cmol(+)/kg Al^{3+} (by 1N KCl) in the fine-earth fraction of one or more horizons with a total thickness of 10 cm or more, between 25 and 50 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower.

Alic Haplocryands

CBFC. Other Haplocryands that have, in some subhorizon between 50 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

1. Two percent or more redox concentrations; *or*

2. A color value, moist, of 4 or more, and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds, or in the matrix if peds are absent; *or*

3. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquic Haplocryands

CBFD. Other Haplocryands that have extractable bases plus 1N-KCl-extractable Al^{3+} totaling less than 2.0 cmol(+)/kg in the fine-earth fraction of one or more horizons with a total thickness of 30 cm or more, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower.

Acrudoxic Haplocryands

CBFE. Other Haplocryands which have, undried, a 1500-kPa water retention of less than 30 percent throughout one or more layers with andic soil properties that have a total thickness of 25 cm more within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Vitric Haplocryands

CBFF. Other Haplocryands that have, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Haplocryands

CBFG. Other Haplocryands that have a xeric moisture regime.

Xeric Haplocryands

CBFH. Other Haplocryands.

Typic Haplocryands

Hydrocryands

Key to subgroups

CBDA. Hydrocryands that have a lithic contact within 50 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Hydrocryands

CBDB. Other Hydrocryands that have a placic horizon within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Placic Hydrocryands

CBDC. Other Hydrocryands that have, in one or more horizons between 50 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

1. Two percent or more redox concentrations; *or*

2. A color value, moist, of 4 or more, and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds, or in the matrix if peds are absent; *or*

3. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquic Hydrocryands

CBDD. Other Hydrocryands that have, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Hydrocryands

CBDE. Other Hydrocryands.

Typic Hydrocryands

Melanocryands

Key to subgroups

CBBA. Melanocryands that have a lithic contact within 50 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Melanocryands

CBBB. Other Melanocryands that have more than 2.0 cmol(+)/kg Al^{3+} (by 1N KCl) in the fine-earth fraction of one or more horizons with a total thickness of 10 cm or more, between 25 and 50 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower.

Alic Melanocryands

CBBC. Other Melanocryands which have, undried, a 1500-kPa water retention of less than 30 percent throughout one or more layers with andic soil properties that have a total thickness of 25 cm more within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Vitric Melanocryands

CBBD. Other Melanocryands.

Typic Melanocryands

Vitricryands

Key to subgroups

CBEA. Vitricryands that have a lithic contact within 50 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Vitricryands

CBEB. Other Vitricryands that have, in one or more horizons between 50 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

1. Two percent or more redox concentrations; *or*

2. A color value, moist, of 4 or more, and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds, or in the matrix if peds are absent; *or*

3. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquic Vitricryands

CBEC. Other Vitricryands that have, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Vitricryands

CBED. Other Vitricryands that have a xeric moisture regime and a mollic or an umbric epipedon.

Humic Xeric Vitricryands

CBEE. Other Vitricryands that have a xeric moisture regime.

Xeric Vitricryands

CBEF. Other Vitricryands which have an argillic or a kandic horizon that has its upper boundary within 125 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Alfic Vitricryands

CBEG. Other Vitricryands that have a mollic or an umbric epipedon.

Humic Vitricryands

CBEH. Other Vitricryands.

Typic Vitricryands

TORRANDS

Key to great groups

CCA. All Torrands.

Vitritorrands, p. 151

Vitritorrands

Key to subgroups

BCAA. Vitritorrands that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Vitritorrands

CCAB. Other Vitritorrands which have a petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Petrocalcic Vitritorrands

CCAC. Other Vitritorrands which have a horizon 15 cm or more thick, with 20 percent or more (by volume) cemented soil material that does not slake in water after air-drying, that has its upper boundary within 100 cm of the mineral soil surface.

Duric Vitritorrands

CCAD. Other Vitritorrands that have, in one or more horizons between 50 and 100 cm from the mineral soil surface, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

1. Two percent or more redox concentrations; *or*

2. A color value, moist, of 4 or more, and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds, or in the matrix if peds are absent; *or*

3. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquic Vitritorrands

CCAE. Other Vitritorrands which have a calcic horizon that has its upper boundary within 125 cm of the mineral soil surface.

Calcic Vitritorrands

CCAF. Other Vitritorrands.

Typic Vitritorrands

UDANDS

Key to great groups

CGA. Udands that have, in half or more of each pedon, a placic horizon within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Placudands, p. 166

CGB. Other Udands that have, in 75 percent or more of each pedon, a cemented layer which does not slake in water after air-drying and which has its upper boundary within 100 cm either of the mineral soil surface, or of

surface, or of the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. More than 6.0 percent organic carbon and colors of a mollic epipedon throughout a layer 50 cm or more thick within 60 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Hydric Pachic Durudands

CGBD. Other Durudands that have, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Durudands

CGBE. Other Durudands.

Typic Durudands

Fulvudands

Key to subgroups

CGDA. Fulvudands that have *both*:

1. A lithic contact within 50 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. Undried, a 1500-kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Hydric Lithic Fulvudands

CGDB. Other Fulvudands that have a lithic contact within 50 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Fulvudands

CGDC. Other Fulvudands that have more than 2.0 cmol(+)/kg Al^{3+} (by 1N KCl) in the fine-earth fraction of one or more horizons with a total thickness of 10 cm or more, between 25 and 50 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower.

Alic Fulvudands

CGDD. Other Fulvudands that have, in one or more horizons between 50 and 100 cm either from the mineral soil surface, or from the top of an organic layer

CGDH. Other Fulvudands that have *both*:

1. Undried, a 1500-kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. More than 6.0 percent organic carbon and colors of a mollic epipedon throughout a layer 50 cm or more thick within 60 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Hydric Pachic Fulvudands

CGDI. Other Fulvudands that have *both*:

1. A sum of extractable bases of more than 25.0 cmol(+)/kg in the fine-earth fraction throughout one or more horizons with a total thickness of 15 cm or more between 25 and 75 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. More than 6.0 percent organic carbon and colors of a mollic epipedon throughout a layer 50 cm or more thick within 60 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Eutric Pachic Fulvudands

CGDJ. Other Fulvudands that have more than 6.0 percent organic carbon and colors of a mollic epipedon throughout a layer 50 cm or more thick within 60 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Pachic Fulvudands

CGDK. Other Fulvudands that have *both*:

1. Undried, a 1500-kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. Between 40 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Hydric Thaptic Fulvudands

cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. Undried, a 1500-kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Acrudoxic Hydric Hapludands

CGFI. Other Hapludands that have, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, *both*:

1. Extractable bases plus 1N-KCl-extractable Al^{3+} totaling less than 2.0 cmol(+)/kg in the fine-earth fraction of one or more horizons with a total thickness of 30 cm or more; *and*

2. A layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Acrudoxic Thaptic Hapludands

CGFJ. Other Hapludands that have *both*:

1. Extractable bases plus 1N-KCl-extractable Al^{3+} totaling less than 2.0 cmol(+)/kg in the fine-earth fraction of one or more horizons with a total thickness of 30 cm or more, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. An argillic or a kandic horizon that has *both*:

a. An upper boundary within 125 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower; *and*

b. A base saturation (by sum of cations) of less than 35 percent throughout its upper 50 cm.

Acrudoxic Ultic Hapludands

CGFK. Other Hapludands that have extractable bases plus 1N-KCl-extractable Al^{3+} totaling less than 2.0 cmol(+)/kg in the fine-earth fraction of one or more horizons with a total thickness of 30 cm or more, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower.

Acrudoxic Hapludands

CGFL. Other Hapludands which have, undried, a 1500-kPa water retention of less than 30 percent throughout one or more layers with andic soil properties that have a total thickness of 25 cm more within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Vitric Hapludands

CGFM. Other Hapludands that have *both*:

1. Undried, a 1500-kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. Between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Hydric Thaptic Hapludands

CGFN. Other Hapludands that have, undried, a 1500-kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Hydric Hapludands

CHFO. Other Hapludands that have *both*:

1. A sum of extractable bases of more than 25.0 cmol(+)/kg in the fine-earth fraction throughout one or more horizons with a total thickness of 15 cm or more between 25 and 75 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. Between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Eutric Thaptic Hapludands

CGFP. Other Hapludands that have, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Hapludands

CGFQ. Other Hapludands that have a sum of extractable bases of more than 25.0 cmol(+)/kg in the fine-earth fraction throughout one or more horizons with a total thickness of 15 cm or more between 25 and 75 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower.

Eutric Hapludands

CGFR. Other Hapludands which have an oxic horizon that has its upper boundary within 125 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Oxic Hapludands

CGFS. Other Hapludands which have an argillic or a kandic horizon that has *both*:

1. An upper boundary within 125 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. A base saturation (by sum of cations) of less than 35 percent throughout its upper 50 cm.

Ultic Hapludands

CGFT. Other Hapludands which have an argillic or a kandic horizon that has its upper boundary within 125 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Alfic Hapludands

CGFU. Other Hapludands.

Typic Hapludands

Hydrudands

Key to subgroups

CGEA. Hydrudands that have a lithic contact within 50 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Hydrudands

CGEB. Other Hydrudands that have, in one or more horizons between 50 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

25 and 50 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. More than 6.0 percent organic carbon and colors of a mollic epipedon throughout a layer 50 cm or more thick within 60 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Alic Pachic Melanudands

CGCE. Other Melanudands that have *both*:

1. More than 2.0 cmol(+)/kg Al^{3+} (by 1N KCl) in the fine-earth fraction of one or more horizons with a total thickness of 10 cm or more, between 25 and 50 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. Between 40 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Alic Thaptic Melanudands

CGCF. Other Melanudands that have more than 2.0 cmol(+)/kg Al^{3+} (by 1N KCl) in the fine-earth fraction of one or more horizons with a total thickness of 10 cm or more, between 25 and 50 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower.

Alic Melanudands

CGCG. Other Melanudands that have, in one or more horizons between 50 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

1. Two percent or more redox concentrations; *or*

2. A color value, moist, of 4 or more, and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds, or in the matrix if peds are absent; *or*

3. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquic Melanudands

CGCH. Other Melanudands that have *both*:

2. A color value, moist, of 4 or more, and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds, or in the matrix if peds are absent; *or*

3. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquic Placudands

CGAC. Other Placudands that have *both*:

1. Extractable bases plus 1N-KCl-extractable Al^{3+} totaling less than 2.0 cmol(+)/kg in the fine-earth fraction of one or more horizons with a total thickness of 30 cm or more, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. Undried, a 1500-kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Acrudoxic Hydric Placudands

CGAD. Other Placudands that have extractable bases plus 1N-KCl-extractable Al^{3+} totaling less than 2.0 cmol(+)/kg in the fine-earth fraction of one or more horizons with a total thickness of 30 cm or more, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower.

Acrudoxic Placudands

CGAE. Other Placudands that have *both*:

1. A sum of extractable bases of more than 25.0 cmol(+)/kg in the fine-earth fraction throughout one or more horizons with a total thickness of 15 cm or more between 25 and 75 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. Undried, a 1500-kPa water retention of less than 30 percent throughout one or more layers with andic soil properties that have a total thickness of 25 cm more within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Eutric Vitric Placudands

CGAF. Other Placudands which have, undried, a 1500-kPa water retention of less than 30 percent throughout one or more layers with andic soil properties that have a total thickness of 25 cm more within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Vitric Placudands

CGAG. Other Placudands that have *both*:

1. Undried, a 1500-kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. More than 6.0 percent organic carbon and colors of a mollic epipedon throughout a layer 50 cm or more thick within 60 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Hydric Pachic Placudands

CGAH. Other Placudands that have more than 6.0 percent organic carbon and colors of a mollic epipedon throughout a layer 50 cm or more thick within 60 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Pachic Placudands

CGAI. Other Placudands that have, undried, a 1500-kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Hydric Placudands

CGAJ. Other Placudands that have, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Placudands

CGAK. Other Placudands that have a sum of extractable bases of more than 25.0 cmol(+)/kg in the fine-earth fraction throughout one or more horizons with a total thickness of 15 cm or more between 25 and 75 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower.

Eutric Placudands

CGAL. Other Placudands.

Typic Placudands

USTANDS

Key to great groups

CFA. Ustands which have a duripan that has its upper boundary within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Durustands, p. 169

CFB. Other Ustands.

Haplustands, p. 170

Durustands

Key to subgroups

CFAA. Durustands that have, in one or more horizons between 50 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

1. Two percent or more redox concentrations; *or*

2. A color value, moist, of 4 or more, and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds, or in the matrix if peds are absent; *or*

3. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquic Durustands

CFAB. Other Durustands that have, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Durustands

CFAC. Other Durustands that have an umbric epipedon.

Humic Durustands

CFAD. Other Durustands.

Typic Durustands

Haplustands

Key to subgroups

CFBA. Haplustands that have a lithic contact within 50 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Haplustands

CFBB. Other Haplustands that have, in one or more horizons between 50 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

1. Two percent or more redox concentrations; *or*

2. A color value, moist, of 4 or more, and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds, or in the matrix if peds are absent; *or*

3. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquic Haplustands

CFBC. Other Haplustands that have *both*:

1. Extractable bases plus 1N-KCl-extractable Al^{3+} totaling less than 15.0 cmol(+)/kg in the fine-earth fraction throughout one or more horizons with a total thickness of 60 cm or more within 75 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. Undried, a 1500-kPa water retention of less than 30 percent throughout one or more layers with andic soil properties that have a total thickness of 25 cm more within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Dystric Vitric Haplustands

CFBD. Other Haplustands which have, undried, a 1500-kPa water retention of less than 30 percent throughout one or more layers with andic soil properties that have a total thickness of 25 cm more within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Vitric Haplustands

CFBE. Other Haplustands that have more than 6.0 percent organic carbon and colors of a mollic epipedon throughout a layer 50 cm or more thick within 60 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Pachic Haplustands

CFBF. Other Haplustands that have, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Haplustands

CFBG. Other Haplustands which have a calcic horizon that has its upper boundary within 125 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Calcic Haplustands

CFBH. Other Haplustands that have extractable bases plus 1N-KCl-extractable Al^{3+} totaling less than 15.0 cmol(+)/kg in the fine-earth fraction throughout one or more horizons with a total thickness of 60 cm or more within 75 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Dystric Haplustands

CFBI. Other Haplustands which have an oxic horizon that has its upper boundary within 125 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Oxic Haplustands

CFBJ. Other Haplustands which have an argillic or a kandic horizon that has its upper boundary within 125 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Alfic Haplustands

CFBK. Other Haplustands that have an umbric epipedon.

Humic Haplustands

CFBL. Other Haplustands.

Typic Haplustands

CEAD. Other Ustivitrands which have a calcic horizon that has its upper boundary within 125 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Calcic Ustivitrands

CEAE. Other Ustivitrands that have an umbric epipedon.

Humic Ustivitrands

CEAF. Other Ustivitrands.

Typic Ustivitrands

XERANDS

Key to great groups

CDA. Xerands that have a 1500-kPa water retention of less than 15 percent on air-dried samples *and* of less than 30 percent on undried samples, throughout one or more horizons with a total thickness of 35 cm or more within 60 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Vitrixerands, p. 176

CDB. Other Xerands that have a melanic epipedon.

Melanoxerands, p. 175

CDC. Other Xerands.

Haploxerands, p. 174

Haploxerands

Key to subgroups

CDCA. Haploxerands that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haploxerands

CDCB. Other Haploxerands that have, in one or more horizons between 50 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

1. Two percent or more redox concentrations; *or*

2. A color value, moist, of 4 or more, and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds, or in the matrix if peds are absent; *or*

3. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquic Haploxerands

CDCC. Other Haploxerands that have, between 25 and 100 cm from the mineral soil surface, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Haploxerands

CDCD. Other Haploxerands which have a calcic horizon that has its upper boundary within 125 cm of the mineral soil surface.

Calcic Haploxerands

CDCE. Other Haploxerands which have an argillic or a kandic horizon that has *both*:

1. An upper boundary within 125 cm of the mineral soil surface; *and*

2. A base saturation (by sum of cations) of less than 35 percent throughout its upper 50 cm.

Ultic Haploxerands

CDCF. Other Haploxerands which have *both*:

1. A mollic or an umbric epipedon; *and*

2. An argillic or a kandic horizon that has its upper boundary within 125 cm of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Alfic Humic Haploxerands

CDCG. Other Haploxerands which have an argillic or a kandic horizon that has its upper boundary within 125 cm of the mineral soil surface.

Alfic Haploxerands

CDCH. Other Haploxerands that have a mollic or an umbric epipedon.

Humic Haploxerands

CDCI. Other Haploxerands.

Typic Haploxerands

Melanoxerands

Key to subgroups

CDBA. Melanoxerands that have more than 6.0 percent organic carbon and colors of a mollic epipedon throughout a layer 50 cm or more thick within 60 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Pachic Melanoxerands

CDBB. Other Melanoxerands.

Typic Melanoxerands

Durargids

Key to subgroups

FABA. Durargids which have, above the duripan, *one or both* of the following:

1. Cracks that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick; *or*

2. A linear extensibility of 6.0 cm or more.

Vertic Durargids

FABB. Other Durargids that have, in one or more horizons within 100 cm of the soil surface, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

1. A chroma of 0, or a hue of 2.5Y or yellower and a chroma of 1; *or*

2. Redox concentrations and 50 percent or more chroma of 2 or less; *or*

3. Fifty percent or more chroma of 2 or less and, in horizons with a total thickness of 25 cm or more within 50 cm of the soil surface, a higher exchangeable sodium percentage (or sodium adsorption ratio) than in the zone with aquic conditions; *or*

4. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquic Durargids

FABC. Other Durargids which have:

1. A duripan that has its upper boundary 18 cm or more below the soil surface; *and*

2. A weighted average percentage of organic carbon, relative to the weighted average ratio of sand to clay, as follows:

a. Within 40 cm of the soil surface, if the upper boundary of the duripan is at a depth of 40 cm or more,

(1) 0.60 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.15 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.64-(0.038 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *or*

b. In the upper 18 cm of the soil, if the upper boundary of the duripan is at a depth of 18 to 40 cm,

(1) 0.72 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.18 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.77-(0.046 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *and*

3. A mean annual soil temperature lower than 22°C, a difference of 5°C or more between mean summer and mean winter soil temperatures at a depth of 50 cm from the soil surface, and an aridic moisture regime that borders on a xeric regime; *and*

4. An argillic horizon that has 35 percent or more clay in the fine-earth fraction of some part, and *either*

a. A clay increase of 15 percent or more (absolute) within a vertical distance of 2.5 cm either within the argillic horizon or at its upper boundary; *or*

b. If there is an Ap horizon directly above the argillic horizon, a clay increase of 10 percent or more (absolute) at the upper boundary of the argillic horizon.

Abruptic Xerollic Durargids

FABD. Other Durargids which have an argillic horizon that has 35 percent or more clay in the fine-earth fraction of some part, and *either*

1. A clay increase of 15 percent or more (absolute) within a vertical distance of 2.5 cm either within the argillic horizon or at its upper boundary; *or*

2. If there is an Ap horizon directly above the argillic horizon, a clay increase of 10 percent or more (absolute) at the upper boundary of the argillic horizon.

Abruptic Durargids

FABE. Other Durargids that have *both*:

1. A mean annual soil temperature lower than 22°C, a difference of 5°C or more between mean summer and mean winter soil temperatures at a depth of 50 cm from the soil surface, and an aridic moisture regime that borders on a xeric regime; *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

(2) 0.15 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.64-(0.038 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *or*

b. In the upper 18 cm of the soil, if the upper boundary of the duripan is at a depth of 18 to 40 cm from the soil surface,

(1) 0.72 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.18 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.77-(0.046 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *and*

3. A mean annual soil temperature lower than 22°C, a difference of 5°C or more between mean summer and mean winter soil temperatures at a depth of 50 cm from the soil surface, and an aridic moisture regime that borders on a xeric regime.
Haploxerollic Durargids

FABH. Other Durargids which do not have a platy or massive duripan that is indurated in any subhorizon.
Haplic Durargids

FABI. Other Durargids that have:

1. A duripan at a depth of 18 cm or more; *and*

2. A weighted average percentage of organic carbon, relative to the weighted average ratio of sand to clay, as follows:

a. In the upper 40 cm of the soil, if the upper boundary of the duripan is 40 cm or more below the soil surface,

(1) 0.60 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.15 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.64-(0.038 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *or*

b. In the upper 18 cm of the soil, if the upper boundary of the duripan is at a depth of 18 to 40 cm from the soil surface,

(1) 0.72 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.18 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.77-(0.046 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *and*

3. A mean annual soil temperature lower than 22°C, a difference of 5°C or more between mean summer and mean winter soil temperatures at a depth of 50 cm from the soil surface, and an aridic moisture regime that borders on a xeric regime.

Xerollic Durargids

FABJ. Other Durargids which have a moisture control section that is dry in all its parts for less than three fourths of the cumulative days per year in 6 or more out of 10 years when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher.

Ustalfic Durargids

FABK. Other Durargids.

Typic Durargids

Haplargids

Key to subgroups

FAEA. Haplargids which have:

1. A frigid or colder soil temperature regime and an aridic moisture regime that borders on an ustic regime; *and*

2. A lithic contact within 50 cm of the soil surface; *and*

3. A weighted average percentage of organic carbon, relative to the weighted average ratio of sand to clay, as follows:

a. In the upper 40 cm of the soil, if the lithic contact is between 40 and 50 cm from the soil surface,

(1) 0.60 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.15 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.64-(0.038 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *or*

b. In the upper 18 cm of the soil, if the lithic contact is between 18 and 40 cm from the soil surface,

(1) 0.72 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.18 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.77-(0.046 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13.

Borollic Lithic Haplargids

FAEB. Other Haplargids which have:

1. A lithic contact within 50 cm of the soil surface; *and*

2. An argillic horizon that is discontinuous horizontally in each pedon; *and*

3. A weighted average percentage of organic carbon, relative to the weighted average ratio of sand to clay, as follows:

a. In the upper 40 cm of the soil, if the lithic contact is between 40 and 50 cm from the soil surface,

(1) 0.60 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.15 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.64-(0.038 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *or*

b. In the upper 18 cm of the soil, if the lithic contact is between 18 and 40 cm from the soil surface,

(1) 0.72 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.18 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.77-(0.046 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *and*

4. A mean annual soil temperature lower than 22°C, a difference of 5°C or more between mean summer and mean winter soil temperatures at a depth of 50 cm from the soil surface, and an aridic moisture regime that borders on a xeric regime.

Lithic Ruptic-Entic Xerollic Haplargids

FAEC. Other Haplargids which have:

1. A lithic contact within 50 cm of the soil surface; *and*

2. A weighted average percentage of organic carbon, relative to the weighted average ratio of sand to clay, as follows:

a. In the upper 40 cm of the soil, if the lithic contact is between 40 and 50 cm from the soil surface,

(1) 0.60 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.15 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.64-(0.038 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *or*

b. In the upper 18 cm of the soil, if the lithic contact is between 18 and 40 cm from the soil surface,

(1) 0.72 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.18 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.77-(0.046 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *and*

3. A mean annual soil temperature lower than 22°C, a difference of 5°C or more between mean summer and mean winter soil temperatures at a depth of 50 cm from the soil surface, and an aridic moisture regime that borders on a xeric regime.

Lithic Xerollic Haplargids

FAED. Other Haplargids which have:

1. A lithic contact within 50 cm of the soil surface; *and*

2. A weighted average percentage of organic carbon, relative to the weighted average ratio of sand to clay, as follows:

a. In the upper 40 cm of the soil, if the lithic contact is between 40 and 50 cm from the soil surface,

(1) 0.60 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.15 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.64-(0.038 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *or*

b. In the upper 18 cm of the soil, if the lithic contact is between 18 and 40 cm from the soil surface,

(1) 0.72 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.18 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.77-(0.046 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *and*

3. A mean annual soil temperature of 8°C or higher, and an aridic moisture regime that borders on an ustic regime.

Lithic Ustollic Haplargids

FAEE. Other Haplargids that have a lithic contact within 50 cm of the soil surface.

Lithic Haplargids

FAEF. Other Haplargids which have:

1. A frigid or colder soil temperature regime; *and*

2. A weighted average percentage of organic carbon, relative to the weighted average ratio of sand to clay, as follows:

a. In the upper 40 cm of the soil, if there is no paralithic contact within 40 cm of the soil surface,

(1) 0.60 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.15 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.64-(0.038 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *or*

b. In the upper 18 cm of the soil, if there is a paralithic contact between 18 and 40 cm from the soil surface,

(1) 0.72 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.18 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.77-(0.046 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *and*

3. *One or both* of the following:

a. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Borollic Vertic Haplargids

1. *One or both* of the following:

a. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower; *and*

2. A mean annual soil temperature of 8°C or higher and an aridic moisture regime that borders on an ustic regime.

Ustertic Haplargids

FAEJ. Other Haplargids which have *one or both* of the following:

1. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Haplargids

FAEK. Other Haplargids that have, in one or more horizons within 100 cm of the soil surface, aquic conditions for some time in most years (or artificial drainage) and *one or more* of the following:

1. A chroma of 0, or a hue of 2.5Y or yellower and a chroma of 1; *or*

2. Redox concentrations and 50 percent or more chroma of 2 or less; *or*

3. Fifty percent or more chroma of 2 or less and, in horizons with a total thickness of 25 cm or more within 50 cm of the soil surface, a higher exchangeable sodium percentage (or sodium adsorption ratio) than in the zone with aquic conditions; *or*

4. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquic Haplargids

FAEL. Other Haplargids which have:

1. A sandy particle size throughout a layer extending from the mineral soil surface to the top

(2) 0.15 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.64-(0.038 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *or*

b. In the upper 18 cm of the soil, if there is a paralithic contact between 18 and 40 cm from the soil surface,

(1) 0.72 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.18 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.77-(0.046 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *and*

2. A mean annual soil temperature lower than 22°C, a difference of 5°C or more between mean summer and mean winter soil temperatures at a depth of 50 cm from the soil surface, and an aridic moisture regime that borders on a xeric regime.
Xerollic Haplargids

FAER. Other Haplargids which have *both*:

1. A moisture control section that is dry in all its parts for less than three fourths of the cumulative days per year in 6 or more out of 10 years when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

2. A mean annual soil temperature lower than 22°C, a difference of 5°C or more between mean summer and mean winter soil temperatures at a depth of 50 cm from the soil surface, and an aridic moisture regime that borders on a xeric regime.
Xeralfic Haplargids

FAES. Other Haplargids which have *both*:

1. A weighted average percentage of organic carbon, relative to the weighted average ratio of sand to clay, as follows:

a. In the upper 40 cm of the soil, if there is no paralithic contact within 40 cm of the soil surface,

(1) 0.60 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.15 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.64-(0.038 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *or*

b. Redox concentrations and 50 percent or more chroma of 2 or less; *or*

c. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquic Haplic Nadurargids

FAAC. Other Nadurargids that have, in one or more horizons within 100 cm of the soil surface, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

1. A chroma of 0, or a hue of 2.5Y or yellower and a chroma of 1; *or*

2. Redox concentrations and 50 percent or more chroma of 2 or less; *or*

3. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquic Nadurargids

FAAD. Other Nadurargids which have:

1. A duripan 18 cm or more below the soil surface that is not indurated in any part; *and*

2. A weighted average percentage of organic carbon, relative to the weighted average ratio of sand to clay, as follows:

a. In the upper 40 cm of the soil, if the upper boundary of the duripan is 40 cm or more below the soil surface,

(1) 0.60 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.15 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.64-(0.038 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *or*

b. In the upper 18 cm of the soil, if the upper boundary of the duripan is between 18 and 40 cm from the soil surface,

(1) 0.72 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.18 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.77-(0.046 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *and*

3. A mean annual soil temperature lower than 22°C, a difference of 5°C or more between mean summer and mean winter soil temperatures at a

depth of 50 cm from the soil surface, and an aridic moisture regime that borders on a xeric regime.

Haploxerollic Nadurargids

FAAE. Other Nadurargids which have a duripan that is not indurated in any subhorizon.

Haplic Nadurargids

FAAF. Other Nadurargids which have:

1. A duripan 18 cm or more below the soil surface; *and*

2. A weighted average percentage of organic carbon, relative to the weighted average ratio of sand to clay, as follows:

a. In the upper 40 cm of the soil, if the upper boundary of the duripan is 40 cm or more below the soil surface,

(1) 0.60 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.15 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.64-(0.038 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *or*

b. In the upper 18 cm of the soil, if the upper boundary of the duripan is between 18 and 40 cm from the soil surface,

(1) 0.72 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.18 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.77-(0.046 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *and*

3. A mean annual soil temperature lower than 22°C, a difference of 5°C or more between mean summer and mean winter soil temperatures at a depth of 50 cm from the soil surface, and an aridic moisture regime that borders on a xeric regime.

Xerollic Nadurargids

FAAG. Other Nadurargids.

Typic Nadurargids

Natrargids

<u>Key to subgroups</u>

FACA. Natrargids which have:

1. A lithic contact within 50 cm of the soil surface; *and*

(3) 0.77-(0.046 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *and*

2. A frigid or colder soil temperature regime, and an aridic moisture regime that borders on an ustic regime.

Borollic Natrargids

FACF. Other Natrargids that have, in one or more horizons within 100 cm of the soil surface, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

1. A chroma of 0, or a hue of 2.5Y or yellower and a chroma of 1; *or*

2. Redox concentrations and 50 percent or more chroma of 2 or less; *or*

3. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquic Natrargids

FACG. Other Natrargids which have:

1. A horizon within 100 cm of the soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist; *and*

2. A weighted average percentage of organic carbon, relative to the weighted average ratio of sand to clay, as follows:

a. In the upper 40 cm of the soil, if there is no paralithic contact within 40 cm of the soil surface,

(1) 0.60 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.15 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.64-(0.038 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *or*

b. In the upper 18 cm of the soil, if there is a paralithic contact between 18 and 40 cm from the soil surface,

(1) 0.72 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.18 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.77-(0.046 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *and*

3. A mean annual soil temperature lower than 22°C, a difference of 5°C or more between mean summer and mean winter soil temperatures at a depth of 50 cm from the soil surface, and an aridic moisture regime that borders on a xeric regime.

Durixerollic Natrargids

FACH. Other Natrargids which have a horizon within 100 cm of the soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

Duric Natrargids

FACI. Other Natrargids which have:

1. Skeletans on 10 percent or more of the faces of peds that are 2.5 cm or more below the upper boundary of the natric horizon; *and*

2. A weighted average percentage of organic carbon, relative to the weighted average ratio of sand to clay, as follows:

a. In the upper 40 cm of the soil, if there is no paralithic contact within 40 cm of the soil surface,

(1) 0.60 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.15 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.64-(0.038 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *or*

b. In the upper 18 cm of the soil, if there is a paralithic contact between 18 and 40 cm from the soil surface,

(1) 0.72 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.18 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.77-(0.046 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *and*

3. An aridic moisture regime that borders on an ustic regime.

Glossic Ustollic Natrargids

FACJ. Other Natrargids which have:

1. An exchangeable sodium percentage of less than 15 (or a sodium adsorption ratio of less than 13) in 50 percent or more of the natric horizon; *and*

2. A weighted average percentage of organic carbon, relative to the weighted average ratio of sand to clay, as follows:

a. In the upper 40 cm of the soil, if there is no paralithic contact within 40 cm of the soil surface,

(1) 0.60 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.15 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.64-(0.038 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *or*

b. In the upper 18 cm of the soil, if there is a paralithic contact between 18 and 40 cm from the soil surface,

(1) 0.72 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.18 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.77-(0.046 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *and*

3. A mean annual soil temperature of 8°C or higher, and an aridic moisture regime that borders on an ustic regime.

Haplustollic Natrargids

FACK. Other Natrargids which have:

1. An exchangeable sodium percentage of less than 15 (or a sodium adsorption ratio of less than 13) in 50 percent or more of the natric horizon; *and*

2. A weighted average percentage of organic carbon, relative to the weighted average ratio of sand to clay, as follows:

a. In the upper 40 cm of the soil, if there is no paralithic contact within 40 cm of the soil surface,

(1) 0.60 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.15 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.64-(0.038 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *or*

b. In the upper 18 cm of the soil, if there is a paralithic contact between 18 and 40 cm from the soil surface,

2. A frigid or colder soil temperature regime; *and*

3. *One or both* of the following:

a. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Borollic Vertic Paleargids

FADB. Other Paleargids which have *both*:

1. A weighted average percentage of organic carbon, relative to the weighted average ratio of sand to clay, as follows:

a. In the upper 40 cm of the soil, if there is no petrocalcic horizon within 40 cm of the soil surface,

(1) 0.60 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.15 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.64-(0.038 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *or*

b. In the upper 18 cm of the soil, if there is a petrocalcic horizon with an upper boundary between 18 and 40 cm from the soil surface,

(1) 0.72 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.18 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.77-(0.046 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *and*

2. A frigid or colder soil temperature regime, and an aridic moisture regime that borders on an ustic regime.

Borollic Paleargids

FADC. Other Paleargids which have *one or both* of the following:

1. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a

a. 0.60 or more, with a sand/clay ratio of 1.0 or less; *or*

b. 0.15 or more, with a sand/clay ratio of 13 or more; *or*

c. 0.64-(0.038 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *and*

2. A mean annual soil temperature lower than 22°C, a difference of 5°C or more between mean summer and mean winter soil temperatures at a depth of 50 cm from the soil surface, and an aridic moisture regime that borders on a xeric regime.

Xerollic Paleargids

FADJ. Other Paleargids which have *both*:

1. A weighted average percentage of organic carbon, relative to the weighted average ratio of sand to clay, between the soil surface and a depth of 40 cm as follows:

a. 0.60 or more, with a sand/clay ratio of 1.0 or less; *or*

b. 0.15 or more, with a sand/clay ratio of 13 or more; *or*

c. 0.64-(0.038 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *and*

2. An aridic moisture regime that borders on an ustic regime.

Ustollic Paleargids

FADK. Other Paleargids which have *both*:

1. A moisture control section that is dry in all its parts for less than three fourths of the cumulative days per year in 6 or more out of 10 years when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

2. A mean annual soil temperature lower than 22°C, a difference of 5°C or more between mean summer and mean winter soil temperatures at a depth of 50 cm from the soil surface, and an aridic moisture regime that borders on a xeric regime.

Xeralfic Paleargids

FADL. Other Paleargids which have *both*:

1. A moisture control section that is dry in all its parts for less than three fourths of the cumulative days per year in 6 or more out of 10 years when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

2. A mean annual soil temperature that is 8°C or higher, and an aridic moisture regime that borders on an ustic regime.

Ustalfic Paleargids

FADM. Other Paleargids.

Typic Paleargids

ORTHIDS

Key to great groups

FBA. Orthids which:

1. Have a salic horizon that has its upper boundary within 75 cm of the soil surface; *and*

2. Are saturated with water within 100 cm of the soil surface for 1 month or more per year in most years (or artificially drained); *and*

3. Do not have a duripan that has its upper boundary within 100 cm of the soil surface.

Salorthids, p. 231

FBB. Other Orthids which have a petrocalcic horizon that has its upper boundary within 100 cm of the soil surface and is not overlain by a duripan.

Paleorthids, p. 228

FBC. Other Orthids which have a duripan that has its upper boundary within 100 cm of the soil surface.

Durorthids, p. 222

FBD. Other Orthids which have a gypsic or petrogypsic horizon that has its upper boundary within 100 cm of the soil surface.

Gypsiorthids, p. 227

FBE. Other Orthids which:

1. Have a calcic horizon that has its upper boundary within 100 cm of the soil surface; *and*

2. In all parts above the calcic horizon, after the materials between the soil surface and a depth of 18 cm have been mixed, are either calcareous or have a texture of loamy fine sand or coarser.

Calciorthids, p. 205

FBF. Other Orthids.

Camborthids, p. 212

Calciorthids

Key to subgroups

FBEA. Calciorthids which have:

1. A frigid soil temperature regime, and an aridic moisture regime that borders on an ustic regime; *and*

2. A lithic contact within 50 cm of the soil surface; *and*

sand/noncarbonate-clay ratio between 1 and 13; *or*

b. In the upper 18 cm of the soil, if there is a paralithic contact between 18 and 40 cm from the soil surface,

(1) 0.72 or more, with a sand/noncarbonate-clay ratio of 1.0 or less; *or*

(2) 0.18 or more, with a sand/noncarbonate-clay ratio of 13 or more; *or*

(3) 0.77-(0.046 x sand/noncarbonate-clay ratio), or more, with a sand/noncarbonate-clay ratio between 1 and 13.

Borollic Calciorthids

FBEC. Other Calciorthids which have:

1. A lithic contact within 50 cm of the soil surface; *and*

2. A weighted average percentage of organic carbon, relative to the weighted average ratio of sand to noncarbonate clay, as follows:

a. In the upper 40 cm of the soil, if the lithic contact is between 40 and 50 cm below the soil surface,

(1) 0.60 or more, with a sand/noncarbonate-clay ratio of 1.0 or less; *or*

(2) 0.15 or more, with a sand/noncarbonate-clay ratio of 13 or more; *or*

(3) 0.64-(0.038 x sand/noncarbonate-clay ratio), or more, with a sand/noncarbonate-clay ratio between 1 and 13; *or*

b. In the upper 18 cm of the soil, if the lithic contact is between 18 and 40 cm from the soil surface,

(1) 0.72 or more, with a sand/noncarbonate-clay ratio of 1.0 or less; *or*

(2) 0.18 or more, with a sand/noncarbonate-clay ratio of 13 or more; *or*

(3) 0.77-(0.046 x sand/noncarbonate-clay ratio), or more, with a sand/noncarbonate-clay ratio between 1 and 13; *and*

3. A mean annual soil temperature lower than 22°C, a difference of 5°C or more between mean summer and mean winter soil temperatures at a depth of 50 cm from the soil surface, and an aridic moisture regime that borders on a xeric regime.

Lithic Xerollic Calciorthids

FBED. Other Calciorthids which have:

1. A lithic contact within 50 cm of the soil surface; *and*

2. A weighted average percentage of organic carbon, relative to the weighted average ratio of sand to noncarbonate clay, as follows:

a. In the upper 40 cm of the soil, if the lithic contact is between 40 and 50 cm below the soil surface,

(1) 0.60 or more, with a sand/noncarbonate-clay ratio of 1.0 or less; *or*

(2) 0.15 or more, with a sand/noncarbonate-clay ratio of 13 or more; *or*

(3) 0.64-(0.038 x sand/noncarbonate-clay ratio), or more, with a sand/noncarbonate-clay ratio between 1 and 13; *or*

b. In the upper 18 cm of the soil, if the lithic contact is between 18 and 40 cm from the soil surface,

(1) 0.72 or more, with a sand/noncarbonate-clay ratio of 1.0 or less; *or*

(2) 0.18 or more, with a sand/noncarbonate-clay ratio of 13 or more; *or*

(3) 0.77-(0.046 x sand/noncarbonate-clay ratio), or more, with a sand/noncarbonate-clay ratio between 1 and 13; *and*

3. An aridic moisture regime that borders on an ustic regime.

Lithic Ustollic Calciorthids

FBEE. Other Calciorthids that have a lithic contact within 50 cm of the soil surface.

Lithic Calciorthids

FBEF. Other Calciorthids which have *both*:

1. A horizon within 100 cm of the soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist; *and*

2. In one or more horizons within 100 cm of the soil surface, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

a. A chroma of 0, or a hue of 2.5Y or yellower and a chroma of 1; *or*

b. Redox concentrations and 50 percent or more chroma of 2 or less; *or*

c. Fifty percent or more chroma of 2 or less and, in horizons with a total thickness of 25 cm or more within 50 cm of the soil surface, a higher exchangeable sodium percentage (or sodium adsorption ratio) than in the zone with aquic conditions; *or*

d. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquic Duric Calciorthids

FBEG. Other Calciorthids that have, in one or more horizons within 100 cm of the soil surface, aquic conditions for some time in most years (or artificial drainage), *and one or more* of the following:

1. A chroma of 0, or a hue of 2.5Y or yellower and a chroma of 1; *or*

2. Redox concentrations and 50 percent or more chroma of 2 or less; *or*

3. Fifty percent or more chroma of 2 or less and, in horizons with a total thickness of 25 cm or more within 50 cm of the soil surface, a higher exchangeable sodium percentage (or sodium adsorption ratio) than in the zone with aquic conditions; *or*

4. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquic Calciorthids

FBEH. Other Calciorthids which have:

1. A horizon within 100 cm of the soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist; *and*

2. A weighted average percentage of organic carbon, relative to the weighted average ratio of sand to noncarbonate clay, as follows:

a. In the upper 40 cm of the soil, if there is no paralithic contact within 40 cm of the soil surface,

(1) 0.60 or more, with a sand/noncarbonate-clay ratio of 1.0 or less; *or*

b. In the upper 18 cm of the soil, if there is a paralithic contact between 18 and 40 cm from the soil surface,

(1) 0.72 or more, with a sand/noncarbonate-clay ratio of 1.0 or less; *or*

(2) 0.18 or more, with a sand/noncarbonate-clay ratio of 13 or more; *or*

(3) 0.77-(0.046 x sand/noncarbonate-clay ratio), or more, with a sand/noncarbonate-clay ratio between 1 and 13; *and*

2. A mean annual soil temperature lower than 22°C, a difference of 5°C or more between mean summer and mean winter soil temperatures at a depth of 50 cm from the soil surface, and an aridic moisture regime that borders on a xeric regime.

Xerollic Calciorthids

FBEK. Other Calciorthids which have *both*:

1. A weighted average percentage of organic carbon, relative to the weighted average ratio of sand to noncarbonate clay, as follows:

a. In the upper 40 cm of the soil, if there is no paralithic contact within 40 cm of the soil surface,

(1) 0.60 or more, with a sand/noncarbonate-clay ratio of 1.0 or less; *or*

(2) 0.15 or more, with a sand/noncarbonate-clay ratio of 13 or more; *or*

(3) 0.64-(0.038 x sand/noncarbonate-clay ratio), or more, with a sand/noncarbonate-clay ratio between 1 and 13; *or*

b. In the upper 18 cm of the soil, if there is a paralithic contact between 18 and 40 cm from the soil surface,

(1) 0.72 or more, with a sand/noncarbonate-clay ratio of 1.0 or less; *or*

(2) 0.18 or more, with a sand/noncarbonate-clay ratio of 13 or more; *or*

(3) 0.77-(0.046 x sand/noncarbonate-clay ratio), or more, with a sand/noncarbonate-clay ratio between 1 and 13; *and*

2. An aridic moisture regime that borders on an ustic regime.

Ustollic Calciorthids

FBEL. Other Calciorthids which have *both*:

1. A moisture control section that is dry in all its parts for less than three fourths of the cumulative days per year in 6 or more out of 10 years when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

2. A mean annual soil temperature lower than 22°C, a difference of 5°C or more between mean summer and mean winter soil temperatures at a depth of 50 cm from the soil surface, and an aridic moisture regime that borders on a xeric regime.

Xerochreptic Calciorthids

FBEM. Other Calciorthids which have *both*:

1. A moisture control section that is dry in all its parts for less than three fourths of the cumulative days per year in 6 or more out of 10 years when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

2. An aridic moisture regime that borders on an ustic regime.

Ustochreptic Calciorthids

FBEN. Other Calciorthids which have reddish peds below the calcic horizon that either are weakly calcareous or noncalcareous but are coated with lime.

Argic Calciorthids

FBEO. Other Calciorthids.

Typic Calciorthids

Camborthids

Key to subgroups

FBFA. Camborthids which have:

1. A lithic contact within 50 cm of the soil surface; *and*

2. A frigid or colder soil temperature regime, and an aridic moisture regime that borders on an ustic regime; *and*

3. A weighted average percentage of organic carbon, relative to the weighted average ratio of sand to clay, as follows:

a. In the upper 40 cm of the soil, if the lithic contact is between 40 and 50 cm below the soil surface,

(1) 0.60 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.15 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.64-(0.038 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *or*

b. In the upper 18 cm of the soil, if the lithic contact is between 18 and 40 cm from the soil surface,

(1) 0.72 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.18 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.77-(0.046 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13.

Borollic Lithic Camborthids

FBFB. Other Camborthids which have:

1. A lithic contact within 50 cm of the soil surface; *and*

2. A horizon within 100 cm of the soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist; *and*

3. A weighted average percentage of organic carbon, relative to the weighted average ratio of sand to clay, as follows:

a. In the upper 40 cm of the soil, if the lithic contact is between 40 and 50 cm below the soil surface,

(1) 0.60 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.15 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.64-(0.038 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *or*

b. In the upper 18 cm of the soil, if the lithic contact is between 18 and 40 cm from the soil surface,

(1) 0.72 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.18 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.77-(0.046 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *and*

4. A mean annual soil temperature lower than 22°C, a difference of 5°C or more between mean

(3) 0.77-(0.046 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13.

Borollic Camborthids

FBFH. Other Camborthids which have *both*:

1. *One or both* of the following:

a. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower; *and*

2. A mean annual soil temperature lower than 22°C, a difference of 5°C or more between mean summer and mean winter soil temperatures at a depth of 50 cm from the soil surface, and an aridic moisture regime that borders on a xeric regime.

Xerertic Camborthids

FBFI. Other Camborthids which have *both*:

1. *One or both* of the following:

a. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower; *and*

2. An aridic moisture regime that borders on an ustic regime.

Ustertic Camborthids

FBFJ. Other Camborthids which have *one or both* of the following:

1. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100

cm or a lithic or paralithic contact, whichever is shallower.

Vertic Camborthids

FBFK. Other Camborthids which have *both*:

1. A horizon within 100 cm of the soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist; *and*

2. In one or more horizons within 100 cm of the soil surface, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

a. A chroma of 0, or a hue of 2.5Y or yellower and a chroma of 1; *or*

b. Redox concentrations and 50 percent or more chroma of 2 or less; *or*

c. Fifty percent or more chroma of 2 or less and, in horizons with a total thickness of 25 cm or more within 50 cm of the soil surface, a higher exchangeable sodium percentage (or sodium adsorption ratio) than in the zone with aquic conditions; *or*

d. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquic Duric Camborthids

FBFL. Other Camborthids that have, in one or more horizons within 100 cm of the soil surface, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

1. A chroma of 0, or a hue of 2.5Y or yellower and a chroma of 1; *or*

2. Redox concentrations and 50 percent or more chroma of 2 or less; *or*

3. Fifty percent or more chroma of 2 or less, and a higher exchangeable sodium percentage (or sodium adsorption ratio) in more than half the thickness of the horizons between the soil surface and a depth of 50 cm than in the saturated zone; *or*

4. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquic Camborthids

FBFM. Other Camborthids which have:

1. A moisture control section that is dry in all its parts for less than three fourths of the cumulative days per year in 6 or more out of 10 years when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

FBFO. Other Camborthids which have:

1. A horizon within 100 cm of the soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist; *and*

2. A weighted average percentage of organic carbon, relative to the weighted average ratio of sand to clay, as follows:

a. In the upper 40 cm of the soil, if there is no paralithic contact within 40 cm of the soil surface,

(1) 0.60 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.15 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.64-(0.038 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *or*

b. In the upper 18 cm of the soil, if there is a paralithic contact between 18 and 40 cm from the soil surface,

(1) 0.72 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.18 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.77-(0.046 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *and*

3. A mean annual soil temperature lower than 22°C, a difference of 5°C or more between mean summer and mean winter soil temperatures at a depth of 50 cm from the soil surface, and an aridic moisture regime that borders on a xeric regime.

Durixerollic Camborthids

FBFP. Other Camborthids which have a horizon within 100 cm of the soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

Duric Camborthids

FBFQ. Other Camborthids which have *either* 0.2 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm either to a depth of 125 cm, or to a lithic or paralithic contact if shallower.

Fluventic Camborthids

FBFR. Other Camborthids that have *both*:

1. An anthropic epipedon; *and*

2. A mean annual soil temperature lower than 22°C, a difference of 5°C or more between mean summer and mean winter soil temperatures at a depth of 50 cm from the soil surface, and an aridic moisture regime that borders on a xeric regime.

Xerollic Camborthids

FBFT. Other Camborthids which have *both*:

1. A weighted average percentage of organic carbon, relative to the weighted average ratio of sand to clay, as follows:

a. In the upper 40 cm of the soil, if there is no paralithic contact within 40 cm of the soil surface,

(1) 0.60 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.15 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.64-(0.038 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *or*

b. In the upper 18 cm of the soil, if there is a paralithic contact between 18 and 40 cm from the soil surface,

(1) 0.72 or more, with a sand/clay ratio of 1.0 or less; *or*

(2) 0.18 or more, with a sand/clay ratio of 13 or more; *or*

(3) 0.77-(0.046 x sand/clay ratio), or more, with a sand/clay ratio between 1 and 13; *and*

2. An aridic moisture regime that borders on an ustic regime.

Ustollic Camborthids

FBFU. Other Camborthids which have *both*:

1. A moisture control section that is dry in all its parts for less than three fourths of the cumulative days per year in 6 or more out of 10 years when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

2. An aridic moisture regime that borders on a xeric regime.

Xerochreptic Camborthids

FBFV. Other Camborthids which have *both*:

1. A moisture control section that is dry in all its parts for less than three fourths of the cumulative days per year in 6 or more out of 10 years when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

2. A hyperthermic, thermic, or mesic soil temperature regime, and an aridic moisture regime that borders on an ustic regime.

Ustochreptic Camborthids

FBFW. Other Camborthids.

Typic Camborthids

Durorthids

Key to subgroups

FBCA. Durorthids which have *both*:

1. A duripan that is not indurated in any subhorizon; *and*

2. In one or more horizons within 100 cm of the soil surface, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

a. A chroma of 0, or a hue of 2.5Y or yellower and a chroma of 1; *or*

b. Redox concentrations and 50 percent or more chroma of 2 or less; *or*

c. Fifty percent or more chroma of 2 or less, and a higher exchangeable sodium percentage (or sodium adsorption ratio) in more than half the thickness of the horizons between the soil surface and 50 cm depth than in the saturated zone; *or*

d. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquentic Durorthids

FBCB. Other Durorthids that have, in one or more horizons within 100 cm of the soil surface, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

1. A chroma of 0, or a hue of 2.5Y or yellower and a chroma of 1; *or*

2. Redox concentrations and 50 percent or more chroma of 2 or less; *or*

3. Fifty percent or more chroma of 2 or less, and a higher exchangeable sodium percentage (or sodium adsorption ratio) in more than half the thickness of the horizons between the soil surface and 50 cm depth than in the saturated zone; *or*

4. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquic Durorthids

FBCC. Other Durorthids which have:

1. An aridic moisture regime that borders on a xeric regime; *and*

2. A moisture control section that is dry in all its parts for less than three fourths of the cumulative days per year in 6 or more out of 10 years when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

3. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

(1) In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

(2) In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Vitrixerandic Durorthids

FBCD. Other Durorthids which have *both*:

1. A moisture control section that is dry in all its parts for less than three fourths of the cumulative days per year in 6 or more out of 10 years when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

(1) In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

3. A weighted average percentage of organic carbon, relative to the weighted average ratio of sand to noncarbonate clay, as follows:

a. In the upper 40 cm of the soil, if the upper boundary of the duripan is 40 cm or more below the soil surface,

(1) 0.60 or more, with a sand/noncarbonate-clay ratio of 1.0 or less; *or*

(2) 0.15 or more, with a sand/noncarbonate-clay ratio of 13 or more; *or*

(3) 0.64-(0.038 x sand/noncarbonate-clay ratio), or more, with a sand/noncarbonate-clay ratio between 1 and 13; *or*

b. In the upper 18 cm of the soil, if the upper boundary of the duripan is between 18 and 40 cm from the soil surface,

(1) 0.72 or more, with a sand/noncarbonate-clay ratio of 1.0 or less; *or*

(2) 0.18 or more, with a sand/noncarbonate-clay ratio of 13 or more; *or*

(3) 0.77-(0.046 x sand/noncarbonate-clay ratio), or more, with a sand/noncarbonate-clay ratio between 1 and 13.

Haplustollic Durorthids

FBCG. Other Durorthids which have *both*:

1. A weighted average percentage of organic carbon, relative to the weighted average ratio of sand to noncarbonate clay, as follows:

a. In the upper 40 cm of the soil, if the upper boundary of the duripan is 40 cm or more below the soil surface,

(1) 0.60 or more, with a sand/noncarbonate-clay ratio of 1.0 or less; *or*

(2) 0.15 or more, with a sand/noncarbonate-clay ratio of 13 or more; *or*

(3) 0.64-(0.038 x sand/noncarbonate-clay ratio), or more, with a sand/noncarbonate-clay ratio between 1 and 13; *or*

b. In the upper 18 cm of the soil, if the upper boundary of the duripan is between 18 and 40 cm from the soil surface,

(1) 0.72 or more, with a sand/noncarbonate-clay ratio of 1.0 or less; *or*

(2) 0.18 or more, with a sand/noncarbonate-clay ratio of 13 or more; *or*

(3) 0.77-(0.046 x sand/noncarbonate-clay ratio), or more, with a sand/noncarbonate-clay ratio between 1 and 13; *and*

2. A mean annual soil temperature lower than 22°C, a difference of 5°C or more between mean summer and mean winter soil temperatures at a depth of 50 cm from the soil surface, and an aridic moisture regime that borders on a xeric regime.
Xerollic Durorthids

FBCH. Other Durorthids which have *both*:

1. An aridic moisture regime that borders on a xeric regime; *and*

2. A moisture control section that is dry in all its parts for less than three fourths of the cumulative days per year in 6 or more out of 10 years when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher.
Xerochreptic Durorthids

FBCI. Other Durorthids which have *both*:

1. An aridic moisture regime that borders on an ustic regime; *and*

2. A weighted average percentage of organic carbon, relative to the weighted average ratio of sand to noncarbonate clay, as follows:

a. In the upper 40 cm of the soil, if the upper boundary of the duripan is 40 cm or more below the soil surface,

(1) 0.60 or more, with a sand/noncarbonate-clay ratio of 1.0 or less; *or*

(2) 0.15 or more, with a sand/noncarbonate-clay ratio of 13 or more; *or*

(3) 0.64-(0.038 x sand/noncarbonate-clay ratio), or more, with a sand/noncarbonate-clay ratio between 1 and 13; *or*

b. In the upper 18 cm of the soil, if the upper boundary of the duripan is between 18 and 40 cm from the soil surface,

(1) 0.72 or more, with a sand/noncarbonate-clay ratio of 1.0 or less; *or*

(2) 0.18 or more, with a sand/noncarbonate-clay ratio of 13 or more; *or*

(3) 0.77-(0.046 x sand/noncarbonate-clay ratio), or more, with a sand/noncarbonate-clay ratio between 1 and 13.

Ustollic Durorthids

FBCJ. Other Durorthids which have a moisture control section that is dry in all its parts for less than three fourths of the cumulative days per year in 6 or more out of 10 years when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher.

Ustochreptic Durorthids

FBCK. Other Durorthids which have a duripan that is not indurated in any subhorizon.

Entic Durorthids

FBCL. Other Durorthids.

Typic Durorthids

Gypsiorthids

Key to subgroups

FBDA. Gypsiorthids which have a petrogypsic horizon that has its upper boundary within 100 cm of the soil surface.

Petrogypsic Gypsiorthids

FBDB. Other Gypsiorthids that have *both*:

1. A calcic horizon above the gypsic horizon; *and*

2. A gypsic horizon for which the product of its gypsum percentage multiplied by its thickness in centimeters, above a depth of 150 cm from the soil surface, is less than 3,000.

Calcic Gypsiorthids

FBDC. Other Gypsiorthids that have a gypsic horizon for which the product of its gypsum percentage multiplied by its thickness in centimeters, above a depth of 150 cm from the soil surface, is less than 3,000.

Cambic Gypsiorthids

FBDD. Other Gypsiorthids.

Typic Gypsiorthids

Paleorthids

Key to subgroups

FBBA. Paleorthids which have *both*:

1. A frigid or colder soil temperature regime, and an aridic moisture regime that borders on an ustic regime; *and*

2. A weighted average percentage of organic carbon, relative to the weighted average ratio of sand to noncarbonate clay, as follows:

a. In the upper 40 cm of the soil, if the upper boundary of the petrocalcic horizon is 40 cm or more below the soil surface,

(1) 0.60 or more, with a sand/noncarbonate-clay ratio of 1.0 or less; *or*

(2) 0.15 or more, with a sand/noncarbonate-clay ratio of 13 or more; *or*

(3) 0.64-(0.038 x sand/noncarbonate-clay ratio), or more, with a sand/noncarbonate-clay ratio between 1 and 13; *or*

b. In the upper 18 cm of the soil, if the upper boundary of the petrocalcic horizon is between 18 and 40 cm from the soil surface,

(1) 0.72 or more, with a sand/noncarbonate-clay ratio of 1.0 or less; *or*

(2) 0.18 or more, with a sand/noncarbonate-clay ratio of 13 or more; *or*

(3) 0.77-(0.046 x sand/noncarbonate-clay ratio), or more, with a sand/noncarbonate-clay ratio between 1 and 13.

Borollic Paleorthids

FBBB. Other Paleorthids that have, in one or more horizons within 100 cm of the soil surface, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

1. A chroma of 0, or a hue of 2.5Y or yellower and a chroma of 1; *or*

2. Redox concentrations and 50 percent or more chroma of 2 or less; *or*

3. Fifty percent or more chroma of 2 or less, and a higher exchangeable sodium percentage (or sodium adsorption ratio) in more than half the

thickness of the horizons between the soil surface and 50 cm depth than in the saturated zone; *or*

4. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquic Paleorthids

FBBC. Other Paleorthids which have *both*:

1. A mean annual soil temperature lower than 22°C, a difference of 5°C or more between mean summer and mean winter soil temperatures at a depth of 50 cm from the soil surface, and an aridic moisture regime that borders on a xeric regime; *and*

2. A weighted average percentage of organic carbon, relative to the weighted average ratio of sand to noncarbonate clay, as follows:

a. In the upper 40 cm of the soil, if the upper boundary of the petrocalcic horizon is 40 cm or more below the soil surface,

(1) 0.60 or more, with a sand/noncarbonate-clay ratio of 1.0 or less; *or*

(2) 0.15 or more, with a sand/noncarbonate-clay ratio of 13 or more; *or*

(3) 0.64-(0.038 x sand/noncarbonate-clay ratio), or more, with a sand/noncarbonate-clay ratio between 1 and 13; *or*

b. In the upper 18 cm of the soil, if the upper boundary of the petrocalcic horizon is between 18 and 40 cm from the soil surface,

(1) 0.72 or more, with a sand/noncarbonate-clay ratio of 1.0 or less; *or*

(2) 0.18 or more, with a sand/noncarbonate-clay ratio of 13 or more; *or*

(3) 0.77-(0.046 x sand/noncarbonate-clay ratio), or more, with a sand/noncarbonate-clay ratio between 1 and 13.

Xerollic Paleorthids

FBBD. Other Paleorthids which have *both*:

1. An aridic moisture regime that borders on an ustic regime; *and*

2. A weighted average percentage of organic carbon, relative to the weighted average ratio of sand to noncarbonate clay, as follows:

FBBG. Other Paleorthids.

Typic Paleorthids

Salorthids

Key to subgroups

FBAA. Salorthids that have a weighted average percentage of organic carbon, relative to the weighted average ratio of sand to noncarbonate clay, between the soil surface and a depth of 40 cm as follows:

1. 0.60 or more, with a sand/noncarbonate-clay ratio of 1.0 or less; *or*

2. 0.15 or more, with a sand/noncarbonate-clay ratio of 13 or more; *or*

3. 0.64-(0.038 x sand/noncarbonate-clay ratio), or more, with a sand/noncarbonate-clay ratio between 1 and 13.

Aquollic Salorthids

FBAB. Other Salorthids.

Typic Salorthids

Chapter 9

Entisols

KEY TO SUBORDERS

KA. Entisols that have *one or more* of the following:

1. Aquic conditions and sulfidic materials within 50 cm of the mineral soil surface; *or*

2. Permanent saturation with water, and a reduced matrix in all horizons below a depth of 25 cm from the mineral soil surface; *or*

3. In a layer between 40 and 50 cm from the mineral soil surface, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

a. A texture finer than loamy fine sand *and*, in 50 percent or more of the matrix, *one or more* of the following:

(1) A chroma of 0; *or*

(2) A chroma of 1 or less and a color value, moist, of 4 or more; *or*

(3) A chroma of 2 or less, and redox concentrations; *or*

b. A texture of loamy fine sand or coarser *and*, in 50 percent or more of the matrix, *one or more* of the following:

(1) A chroma of 0; *or*

(2) A hue of 10YR or redder, a color value, moist, of 4 or more, and a chroma of 1; *or*

(3) A hue of 10YR or redder, a chroma of 2 or less, and redox concentrations; *or*

(4) A hue of 2.5Y or yellower, a chroma of 3 or less, and distinct or prominent redox concentrations; *or*

(5) A hue of 2.5Y or yellower and a chroma of 1; *or*

(6) A hue of 5GY, 5G, 5BG, or 5B; *or*

(7) Any color if it results from uncoated sand grains; *or*

c. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquents, p. 234

KB. Other Entisols which have, in one or more layers between 25 and 100 cm from the mineral soil surface, 3 percent or more (by volume) fragments of diagnostic horizons that are not arranged in any discernible order.

Arents, p. 241

KC. Other Entisols that have less than 35 percent (by volume) rock fragments and a texture of loamy fine sand or coarser, in all layers[1] between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 100 cm or a lithic, paralithic, or petroferric contact, whichever is shallower.

Psamments, p. 262

KD. Other Entisols which do not have a lithic or paralithic contact within 25 cm of the mineral soil surface, and have:

1. A slope of less than 25 percent; *and*

2. *Either* 0.2 percent or more organic carbon[2] at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a lithic or paralithic contact if shallower; *and*

3. A mean annual soil temperature above 0°C.

Fluvents, p. 242

KE. Other Entisols.

Orthents, p. 251

AQUENTS

Key to great groups

KAA. Aquents that have sulfidic materials within 50 cm of the mineral soil surface.

Sulfaquents, p. 240

KAB. Other Aquents that have *both*:

1. An *n* value of more than 0.7, *and* 8 percent or more clay in the fine-earth fraction of all horizons between 20 and 50 cm from the mineral soil surface; *and*

2. A mean annual soil temperature above 0°C.

Hydraquents, p. 240

KAC. Other Aquents that have a cryic soil temperature regime.

Cryaquents, p. 235

---

[1] Lamellae that are either less than 1 cm thick or too few to meet the requirements for an argillic horizon may have a texture of sandy loam.

[2] The carbon should be of Holocene age, not fossil carbon from transported fragments of bedrock or from buried Pleistocene deposits. The mean residence time of the carbon should be less than 11,000 years B.P.

KAD. Other Aquents that have a sandy particle size in all horizons between either the Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Psammaquents, p. 240

KAE. Other Aquents that have *either* 0.2 percent or more organic carbon[3] at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a lithic or paralithic contact if shallower.

Fluvaquents, p. 237

KAF. Other Aquents that have episaturation.

Epiaquents, p. 236

KAG. Other Aquents.

Endoaquents, p. 236

Cryaquents

Key to subgroups

KACA. Cryaquents which have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

3. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

   a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

   b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Aquandic Cryaquents

KACB. Other Cryaquents.

Typic Cryaquents

ENT

---

[3] See footnote 2.

depth of 75 cm, colors in 50 percent or more of the matrix as follows:

1. A hue of 2.5Y or redder, a color value, moist, of 6 or more, and a chroma of 3 or more; *or*

2. A hue of 2.5Y or redder, a color value, moist, of 5 or less, and a chroma of 2 or more; *or*

3. A hue of 5Y and a chroma of 3 or more; *or*

4. A chroma of 2 or more if there are no redox concentrations.

Aeric Epiaquents

KAFB. Other Epiaquents which have *both*:

1. An Ap horizon, or an A horizon 15 cm or more thick, that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample); *and*

2. A base saturation (by NH_4OAc) of less than 50 percent at a depth of 100 cm from the mineral soil surface.

Humaqueptic Epiaquents

KAFC. Other Epiaquents which have either an Ap horizon, or an A horizon 15 cm or more thick, that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample).

Mollic Epiaquents

KAFD. Other Epiaquents.

Typic Epiaquents

Fluvaquents

Key to subgroups

KAEA. Fluvaquents which have, within 100 cm of the mineral soil surface, *one or both* of the following:

1. Sulfidic materials; *or*

2. A horizon 15 cm or more thick that has all the characteristics of a sulfuric horizon, except that it has a pH value between 3.5 and 4.0.

Sulfic Fluvaquents

KAEB. Other Fluvaquents which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a

cm, colors in 50 percent or more of the matrix as follows:

a. A hue of 2.5Y or redder, a color value, moist, of 6 or more, and a chroma of 3 or more; *or*

b. A hue of 2.5Y or redder, a color value, moist, of 5 or less, and a chroma of 2 or more; *or*

c. A hue of 5Y and a chroma of 3 or more; *or*

d. A chroma of 2 or more if there are no redox concentrations.

Aeric Tropic Fluvaquents

KAEG. Other Fluvaquents that have, in one or more horizons between either the Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm, colors in 50 percent or more of the matrix as follows:

1. A hue of 2.5Y or redder, a color value, moist, of 6 or more, and a chroma of 3 or more; *or*

2. A hue of 2.5Y or redder, a color value, moist, of 5 or less, and a chroma of 2 or more; *or*

3. A hue of 5Y and a chroma of 3 or more; *or*

4. A chroma of 2 or more if there are no redox concentrations.

Aeric Fluvaquents

KAEH. Other Fluvaquents that have a difference of less than 5°C between mean summer and mean winter soil temperatures, either at a depth of 50 cm from the soil surface or at a lithic or paralithic contact, whichever is shallower.

Tropic Fluvaquents

KAEI. Other Fluvaquents which have *both*:

1. An Ap horizon, or an A horizon 15 cm or more thick, that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample); *and*

2. A base saturation (by NH_4OAc) of less than 50 percent at a depth of 100 cm from the mineral soil surface.

Humaqueptic Fluvaquents

KAEJ. Other Fluvaquents which have an Ap horizon, or an A horizon 15 cm or more thick, that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample).

Mollic Fluvaquents

KAEK. Other Fluvaquents.

Typic Fluvaquents

Hydraquents

Key to subgroups

KABA. All Hydraquents (provisionally).

Typic Hydraquents

Psammaquents

Key to subgroups

KADA. Psammaquents that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Psammaquents

KADB. Other Psammaquents which have a horizon 5 cm or more thick, either below an Ap horizon or at a depth of 18 cm or more from the mineral soil surface, whichever is deeper, that has *one or more* of the following:

1. In 25 percent or more of each pedon, cementation by organic matter and aluminum, with or without iron; *or*

2. Aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.25 or more, and half that amount or less in an overlying horizon; *or*

3. An ODOE value of 0.12 or more, and a value half as high or lower in an overlying horizon.

Spodic Psammaquents

KADC. Other Psammaquents which have *both*:

1. An Ap horizon, or an A horizon 15 cm or more thick, that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample); *and*

2. A base saturation (by NH_4OAc) of less than 50 percent in horizons with a total thickness of 50 cm or more within 100 cm of the mineral soil surface.

Humaqueptic Psammaquents

KADD. Other Psammaquents which have either an Ap horizon, or an A horizon 15 cm or more thick, that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample).

Mollic Psammaquents

KADE. Other Psammaquents.

Typic Psammaquents

Sulfaquents

Key to subgroups

KAAA. Sulfaquents that have a histic epipedon.

Histic Sulfaquents

KAAB. Other Sulfaquents which have *both*:

1. Sulfidic materials that have their upper boundary 30 cm or more below the mineral soil surface; *and*

2. An *n* value of 0.7 or less in one or more horizons between 20 and 50 cm from the mineral soil surface.

Haplic Sulfaquents

KAAC. Other Sulfaquents.

Typic Sulfaquents

ARENTS

Key to great groups

KBA. Arents that have an ustic moisture regime.

Ustarents, p. 242

KBB. Other Arents that have a xeric moisture regime.

Xerarents, p. 242

KBC. Other Arents that have a torric moisture regime.

Torriarents, p. 241

KBD. Other Arents.

Udarents, p. 241

Torriarents

Torriarents are the Arents that have a torric soil moisture regime.

Udarents

Key to subgroups

KBDA. Udarents that have fragments of an argillic horizon with a base saturation (by sum of cations) of 35 percent or more within 100 cm of the mineral soil surface.

Alfic Udarents

KBDB. Other Udarents that have fragments of an argillic horizon within 100 cm of the mineral soil surface.

Ultic Udarents

KBDC. Other Udarents that have fragments of a mollic epipedon within 100 cm of the mineral soil surface.

Mollic Udarents

KBDD. Other Udarents.

Udarents

Ustarents

Ustarents are the Arents that have an ustic soil moisture regime.

Xerarents

Key to subgroups

KBBA. Xerarents that have fragments of an argillic horizon with a base saturation (by sum of cations) of 35 percent or more within 100 cm of the mineral soil surface.

Alfic Xerarents

KBBB. Other Xerarents.

Xerarents

FLUVENTS

Key to great groups

KDA. Fluvents that have a cryic soil temperature regime.

Cryofluvents, p. 242

KDB. Other Fluvents that have a xeric moisture regime.

Xerofluvents, p. 249

KDC. Other Fluvents that have an ustic moisture regime.

Ustifluvents, p. 247

KDD. Other Fluvents that have a torric moisture regime.

Torrifluvents, p. 243

KDE. Other Fluvents that have an isomesic, isothermic, or isohyperthermic soil temperature regime.

Tropofluvents, p. 246

KDF. Other Fluvents.

Udifluvents, p. 246

Cryofluvents

Key to subgroups

KDAA. Cryofluvents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Cryofluvents

KDAB. Other Cryofluvents that have, throughout one or more horizons with a total thickness of 18 cm or more

within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

    a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

    b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Vitrandic Cryofluvents

KDAC. Other Cryofluvents that have, in one or more horizons within 50 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Cryofluvents

KDAD. Other Cryofluvents that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Cryofluvents

KDAE. Other Cryofluvents which have an Ap horizon, or an A horizon 15 cm or more thick, that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample).

Mollic Cryofluvents

KDAF. Other Cryofluvents.

Typic Cryofluvents

Torrifluvents

Key to subgroups

KDDA. Torrifluvents which have:

1. *One or both* of the following:

    a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

    b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either

a depth of 100 cm or a lithic or paralithic contact, whichever is shallower; *and*

2. A moisture control section which, in 6 or more out of 10 years, is dry in all its parts for less than three fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

3. A hyperthermic, thermic, mesic, frigid, or an *iso* soil temperature regime, and a torric moisture regime that borders on an ustic regime.

Ustertic Torrifluvents

KDDB. Other Torrifluvents which have *one or both* of the following:

1. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Torrifluvents

KDDC. Other Torrifluvents which have:

1. A moisture control section which, in 6 or more out of 10 years, is dry in all its parts for less than three fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

2. A thermic, mesic, or frigid soil temperature regime, and a torric moisture regime that borders on a xeric regime; *and*

3. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

(1) In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

(2) In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus

1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Vitrixerandic Torrifluvents

KDDD. Other Torrifluvents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

   a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

   b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Vitrandic Torrifluvents

KDDE. Other Torrifluvents that have, in one or more horizons within 100 cm of the soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Torrifluvents

KDDF. Other Torrifluvents that are saturated with water, in one or more layers within 150 cm of the soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Torrifluvents

KDDG. Other Torrifluvents which have:

1. A horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist; *and*

2. A moisture control section which, in 6 or more out of 10 years, is dry in all its parts for less than three fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

3. A thermic, mesic, or frigid soil temperature regime, and a torric moisture regime that borders on a xeric regime.

Durorthidic Xeric Torrifluvents

KDDH. Other Torrifluvents which have a horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

Durorthidic Torrifluvents

KDDI. Other Torrifluvents which have *both*:

1. A moisture control section which, in 6 or more out of 10 years, is dry in all its parts for less than three fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

2. A torric moisture regime that borders on an ustic regime.

Ustic Torrifluvents

KDDJ. Other Torrifluvents which have *both*:

1. A moisture control section which, in 6 or more out of 10 years, is dry in all its parts for less than three fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

2. A thermic, mesic, or frigid soil temperature regime, and a torric moisture regime that borders on a xeric regime.

Xeric Torrifluvents

KDDK. Other Torrifluvents that have an anthropic epipedon.

Anthropic Torrifluvents

KDDL. Other Torrifluvents.

Typic Torrifluvents

Tropofluvents

Key to subgroups

KDEA. All Tropofluvents (provisionally).

Typic Tropofluvents

Udifluvents

Key to subgroups

KDFA. Udifluvents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Udifluvents

KDFB. Other Udifluvents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Ustifluvents

KDCB. Other Ustifluvents that have anthraquic conditions.

Anthraquic Ustifluvents

KDCC. Other Ustifluvents that have *either*:

1. In one or more horizons within 50 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *or*

2. In one or more horizons within 150 cm of the mineral soil surface, a color value, moist, of 4 or more and either a chroma of 0 or a hue of 5GY, 5G, 5BG, or 5B, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Ustifluvents

KDCD. Other Ustifluvents that are saturated with water, in one or more layers within 150 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Ustifluvents

KDCE. Other Ustifluvents which, if neither irrigated nor fallowed to store moisture, have *one* of the following:

1. A frigid soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in all parts for four tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

3. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is moist in some or all parts for less than 180 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Aridic Ustifluvents

KDCF. Other Ustifluvents which, if neither irrigated nor fallowed to store moisture, have *one* of the following:

1. A frigid soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 105 cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for less than four tenths of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

3. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Udic Ustifluvents

KDCG. Other Ustifluvents which have an Ap horizon, or an A horizon 15 cm or more thick, that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample).

Mollic Ustifluvents

KDCH. Other Ustifluvents.

Typic Ustifluvents

Xerofluvents

Key to subgroups

KDBA. Xerofluvents which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Xerofluvents

KDBB. Other Xerofluvents which have:

1. In one or more horizons within 50 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *or*

2. In one or more horizons within 150 cm of the mineral soil surface, a color value, moist, of 4 or

more and either a chroma of 0 or a hue bluer than 10Y, and also aquic conditions for some time in most years (or artificial drainage); *and*

3. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

a. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

b. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

c. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

(1) In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

(2) In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Aquandic Xerofluvents

KDBC. Other Xerofluvents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Xerofluvents

KDBD. Other Xerofluvents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron

percentages (by ammonium oxalate) totaling 0.40 or more.

Vitrandic Xerofluvents

KDBE. Other Xerofluvents that have *either*:

1. In one or more horizons within 50 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *or*

2. In one or more horizons within 150 cm of the mineral soil surface, a color value, moist, of 4 or more and either a chroma of 0 or a hue of 5GY, 5G, 5BG, or 5B; and also aquic conditions for some time in most years (or artificial drainage).

Aquic Xerofluvents

KDBF. Other Xerofluvents that are saturated with water, in one or more layers within 150 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Xerofluvents

KDBG. Other Xerofluvents which have a horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

Durorthidic Xerofluvents

KDBH. Other Xerofluvents which have an Ap horizon, or an A horizon 15 cm or more thick, that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample).

Mollic Xerofluvents

KDBI. Other Xerofluvents.

Typic Xerofluvents

ORTHENTS

Key to great groups

KEA. Orthents that have a cryic or pergelic soil temperature regime.

Cryorthents, p. 252

KEB. Other Orthents that have a torric moisture regime.

Torriorthents, p. 253

KEC. Other Orthents that have a xeric moisture regime.

Xerorthents, p. 260

KED. Other Orthents that have a udic moisture regime, and a difference of less than 5°C between mean summer and mean winter soil temperatures at a depth of 50 cm from the soil surface.

Troporthents, p. 256

2. A moisture control section which, in 6 or more out of 10 years, is dry in all its parts for less than three fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

3. A thermic, mesic, or frigid soil temperature regime, and a torric moisture regime that borders on a xeric regime.

Xerertic Torriorthents

KEBC. Other Torriorthents which have *one or both* of the following:

1. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Torriorthents

KEBD. Other Torriorthents which have:

1. A lithic contact within 50 cm of the soil surface; *and*

2. A moisture control section which, in 6 or more out of 10 years, is dry in all its parts for less than three fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

3. A hyperthermic, thermic, mesic, frigid, or an *iso* soil temperature regime, and a torric moisture regime that borders on an ustic regime.

Lithic Ustic Torriorthents

KEBE. Other Torriorthents which have:

1. A lithic contact within 50 cm of the soil surface; *and*

2. A moisture control section which, in 6 or more out of 10 years, is dry in all its parts for less than three fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

3. A thermic, mesic, or frigid soil temperature regime, and a torric moisture regime that borders on a xeric regime.

Lithic Xeric Torriorthents

KEBF. Other Torriorthents that have a lithic contact within 50 cm of the soil surface.

Lithic Torriorthents

KEBG. Other Torriorthents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

   a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

   b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Vitrandic Torriorthents

KEBH. Other Torriorthents that have *both*:

1. In one or more horizons within 100 cm of the soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. A horizon within 100 cm of the soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

Aquic Durorthidic Torriorthents

KEBI. Other Torriorthents that have, in one or more horizons within 100 cm of the soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Torriorthents

KEBJ. Other Torriorthents that are saturated with water, in one or more layers within 150 cm of the soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Torriorthents

KEBK. Other Torriorthents which have:

1. A horizon within 100 cm of the soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist; *and*

2. A moisture control section which, in 6 or more out of 10 years, is dry in all its parts for less than three fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

KEFD. Other Udorthents that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Udorthents

KEFE. Other Udorthents that are saturated with water, in one or more layers within 150 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Udorthents

KEFF. Other Udorthents that have 50 percent or more (by volume) wormholes, worm casts, and filled animal burrows between either the Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 100 cm or a lithic, paralithic, or petroferric contact, whichever is shallower.

Vermic Udorthents

KEFG. Other Udorthents.

Typic Udorthents

Ustorthents

Key to subgroups

KEEA. Ustorthents that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Ustorthents

KEEB. Other Ustorthents which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Ustorthents

KEEC. Other Ustorthents that have anthraquic conditions.

Anthraquic Ustorthents

KEED. Other Ustorthents that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Ustorthents

KEEE. Other Ustorthents that are saturated with water, in one or more layers within 150 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Ustorthents

KEEF. Other Ustorthents which have a horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

Durorthidic Ustorthents

KEEG. Other Ustorthents which, if neither irrigated nor fallowed to store moisture, have *one* of the following:

1. A frigid soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in all parts for four tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

3. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is moist in some or all parts for less than 180 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Aridic Ustorthents

KEEH. Other Ustorthents which, if neither irrigated nor fallowed to store moisture, have *one* of the following:

1. A frigid soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 105 cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for less than four tenths of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

3. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative

KECC. Other Xerorthents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Xerorthents

KECD. Other Xerorthents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

    a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

    b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Vitrandic Xerorthents

KECE. Other Xerorthents that have *both*:

1. In one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. A horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

Aquic Durorthidic Xerorthents

KECF. Other Xerorthents that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Xerorthents

KECG. Other Xerorthents that are saturated with water, in one or more layers within 150 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Xerorthents

KECH. Other Xerorthents which have a horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

Durorthidic Xerorthents

KECI. Other Xerorthents that have a base saturation (by NH_4OAc) of less than 60 percent in all horizons between 25 and 75 cm from the mineral soil surface.

Dystric Xerorthents

KECJ. Other Xerorthents.

Typic Xerorthents

PSAMMENTS

Key to great groups

KCA. Psamments that have a cryic or pergelic soil temperature regime.

Cryopsamments, p. 262

KCB. Other Psamments that have a torric moisture regime.

Torripsamments, p. 265

KCC. Other Psamments that have, within the particle-size control section, more than 90 percent silica and other extremely durable minerals in the 0.02-to-2.0-mm fraction.

Quartzipsamments, p. 263

KCD. Other Psamments that have a udic moisture regime, and a difference of less than 5°C between mean summer and mean winter soil temperatures at a depth of 50 cm from the soil surface.

Tropopsamments, p. 266

KCE. Other Psamments that have an ustic moisture regime.

Ustipsamments, p. 268

KCF. Other Psamments that have a xeric moisture regime.

Xeropsamments, p. 268

KCG. Other Psamments.

Udipsamments, p. 267

Cryopsamments

Key to subgroups

KCAA. Cryopsamments that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Cryopsamments

KCAB. Other Cryopsamments that have a mean annual soil temperature of 0°C or lower.

Pergelic Cryopsamments

KCAC. Other Cryopsamments that have, in one or more horizons within 50 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Cryopsamments

KCAD. Other Cryopsamments that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Cryopsamments

KCAE. Other Cryopsamments which have a horizon 5 cm or more thick that has *one or more* of the following:

1. In 25 percent or more of each pedon, cementation by organic matter and aluminum, with or without iron; *or*

2. Aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.25 or more, and half that amount or less in an overlying horizon; *or*

3. An ODOE value of 0.12 or more, and a value half as high or lower in an overlying horizon.

Spodic Cryopsamments

KCAF. Other Cryopsamments which have lamellae within 200 cm of the mineral soil surface that meet all the requirements for an argillic horizon except thickness.

Argic Cryopsamments

KCAG. Other Cryopsamments.

Typic Cryopsamments

Quartzipsamments

Key to subgroups

KCCA. Quartzipsamments that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Quartzipsamments

KCCB. Other Quartzipsamments which have *both*:

1. In one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. A horizon 5 cm or more thick, either below an Ap horizon or at a depth of 18 cm or more from the mineral soil surface, whichever is deeper, that has *one or more* of the following:

a. In 25 percent or more of each pedon, cementation by organic matter and aluminum, with or without iron; *or*

b. Aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.25 or more, and half that amount or less in an overlying horizon; *or*

c. An ODOE value of 0.12 or more, and a value half as high or lower in an overlying horizon.

Aquodic Quartzipsamments

KCCC. Other Quartzipsamments that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Quartzipsamments

KCCD. Other Quartzipsamments that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Quartzipsamments

KCCE. Other Quartzipsamments which have *both*:

1. An ustic moisture regime; *and*

2. A clay fraction with a CEC equal to that of the clay of an oxic horizon, and enough clay to coat 75 percent or more of the sand-grain surfaces.

Ustoxic Quartzipsamments

KCCF. Other Quartzipsamments which have *both*:

1. A udic moisture regime; *and*

2. A clay fraction with a CEC equal to that of the clay of an oxic horizon, and enough clay to coat 75 percent or more of the sand-grain surfaces.

Udoxic Quartzipsamments

KCCG. Other Quartzipsamments that have 5 percent or more (by volume) plinthite in one or more horizons within 100 cm of the mineral soil surface.

Plinthic Quartzipsamments

KCCH. Other Quartzipsamments which have *both*:

1. Lamellae within 200 cm of the mineral soil surface that meet all the requirements for an argillic horizon except thickness[5] or clay content; *and*

2. An ustic moisture regime.

Argic Ustic Quartzipsamments

---

[5] The clay content of very thin lamellae cannot be estimated with precision. The lamellae in soils of argic subgroups are generally about 0.5 to 1 cm thick, but their total thickness is less than the 15 cm required for an argillic horizon.

KCCI. Other Quartzipsamments which have lamellae within 200 cm of the mineral soil surface that meet all the requirements for an argillic horizon except thickness[6] or clay content.

Argic Quartzipsamments

KCCJ. Other Quartzipsamments that have an ustic moisture regime.

Ustic Quartzipsamments

KCCK. Other Quartzipsamments that have a xeric moisture regime.

Xeric Quartzipsamments

KCCL. Other Quartzipsamments which have a horizon 5 cm or more thick, either below an Ap horizon or at a depth of 18 cm or more from the mineral soil surface, whichever is deeper, that has *one or more* of the following:

1. In 25 percent or more of each pedon, cementation by organic matter and aluminum, with or without iron; *or*

2. Aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.25 or more, and half that amount or less in an overlying horizon; *or*

3. An ODOE value of 0.12 or more, and a value half as high or lower in an overlying horizon.

Spodic Quartzipsamments

KCCM. Other Quartzipsamments.

Typic Quartzipsamments

Torripsamments

Key to subgroups

KCBA. Torripsamments that have a lithic contact within 50 cm of the soil surface.

Lithic Torripsamments

KCBB. Other Torripsamments which have:

1. A horizon within 100 cm of the soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist; *and*

2. A moisture control section which, in 6 or more out of 10 years, is dry in all its parts for less than three fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

---

[6] See footnote 5.

3. A thermic, mesic, or frigid soil temperature regime, and a torric moisture regime that borders on a xeric regime.

Durorthidic Xeric Torripsamments

KCBC. Other Torripsamments which have a horizon within 100 cm of the soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

Durorthidic Torripsamments

KCBD. Other Torripsamments which have *both*:

1. A moisture control section which, in 6 or more out of 10 years, is dry in all its parts for less than three fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

2. A torric moisture regime that borders on an ustic regime.

Ustic Torripsamments

KCBE. Other Torripsamments which have *both*:

1. A moisture control section which, in 6 or more out of 10 years, is dry in all its parts for less than three fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

2. A thermic, mesic, or frigid soil temperature regime, and a torric moisture regime that borders on a xeric regime.

Xeric Torripsamments

KCBF. Other Torripsamments.

Typic Torripsamments

Tropopsamments

Key to subgroups

KCDA. Tropopsamments that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Tropopsamments

KCDB. Tropopsamments that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Tropopsamments

KCDC. Other Tropopsamments that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Tropopsamments

KCDD. Other Tropopsamments.

Typic Tropopsamments

Udipsamments

Key to subgroups

KCGA. Udipsamments that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Udipsamments

KCGB. Other Udipsamments that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Udipsamments

KCGC. Other Udipsamments that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Udipsamments

KCGD. Other Udipsamments which have a horizon 5 cm or more thick, either below an Ap horizon or at a depth of 18 cm or more from the mineral soil surface, whichever is deeper, that has *one or more* of the following:

1. In 25 percent or more of each pedon, cementation by organic matter and aluminum, with or without iron; *or*

2. Aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.25 or more, and half that amount or less in an overlying horizon; *or*

3. An ODOE value of 0.12 or more, and a value half as high or lower in an overlying horizon.

Spodic Udipsamments

KCGE. Other Udipsamments which have lamellae within 200 cm of the mineral soil surface that meet all the requirements for an argillic horizon except thickness[7] or clay content.

Argic Udipsamments

KCGF. Other Udipsamments which have a surface horizon between 25 and 50 cm thick that meets all the requirements for a plaggen epipedon except thickness.

Plaggeptic Udipsamments

KCGG. Other Udipsamments.

Typic Udipsamments

---

[7] The clay content of very thin lamellae cannot be estimated with precision. The lamellae in soils of argic subgroups are generally about 0.5 to 1 cm thick, but their total thickness is less than the 15 cm required for an argillic horizon.

KCFD. Other Xeropsamments that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Xeropsamments

KCFE. Other Xeropsamments which have a horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

Durorthidic Xeropsamments

KCFF. Other Xeropsamments which have lamellae within 200 cm of the mineral soil surface that meet all the requirements for an argillic horizon except thickness[9] or clay content.

Argic Xeropsamments

KCFG. Other Xeropsamments that have a base saturation (by NH_4OAc) of less than 60 percent in all horizons between 25 and 75 cm from the mineral soil surface.

Dystric Xeropsamments

KCFH. Other Xeropsamments.

Typic Xeropsamments

[9] See footnote 7.

Chapter 10

Histosols

KEY TO SUBORDERS

AA. Histosols which are never saturated with water except for a few days following heavy rains, *and* which have *both*:

1. A lithic or paralithic contact within 100 cm of the soil surface, and/or fragmental materials resting on a lithic or paralithic contact; *and*

2. Less than three fourths (by volume) *Sphagnum* fibers in the organic soil materials.

Folists, p. 278

AB. Other Histosols which *either*:

1. Are dominantly[1] fibric *either*

a. In the subsurface tier if that tier is wholly organic except for one or more thin mineral layers; *or*

b. In the organic parts of the surface and subsurface tiers if there is a continuous mineral layer 40 cm or more thick that has its upper boundary within the subsurface tier; *or*

2. Have a surface mantle in which *Sphagnum* fibers constitute three fourths or more of the volume, and which rests on a lithic or paralithic contact, fragmental materials, mineral soil, or frozen[2] materials within the surface or subsurface tier.

Fibrists, p. 272

AC. Other Histosols that are dominantly[3] hemic *either*:

1. In the subsurface tier if that tier is wholly organic except for one or more thin mineral layers; *or*

---

[1] *Dominant*, in this context, means "the most abundant." If only two kinds of organic materials are present, the fibric materials, if dominant, constitute half or more of the volume. If there are both hemic and sapric materials as well as fibric, the fibric materials, if dominant, may constitute less than half of the volume but have more volume than either the hemic or the sapric materials.

[2] Frozen 2 months after the summer solstice.

[3] *Dominant*, in this context, means the most abundant of the three different kinds of organic soil materials (fibric, hemic, or sapric).

2. In the organic parts of the surface and subsurface tiers if there is a continuous mineral layer 40 cm or more thick that has its upper boundary within the subsurface tier.

Hemists, p. 279

AD. Other Histosols.

Saprists, p. 284

FIBRISTS

Key to great groups

ABA. Fibrists that have a surface mantle in which fibric *Sphagnum* constitutes three fourths or more of the volume and which is *either* 90 cm or more thick, *or* extends 10 cm or more below the upper boundary of frozen[4] soil materials, *or* rests on a lithic or paralithic contact, fragmental materials, or mineral soil materials.

Sphagnofibrists, p. 276

ABB. Other Fibrists which, in most years, *either*:

1. Are frozen in one or more layers within the control section 2 months after the summer solstice; *or*

2. Never freeze below a depth of 5 cm from the soil surface but have a mean annual soil temperature lower than 8°C.

Cryofibrists, p. 274

ABC. Other Fibrists that have a mean annual soil temperature lower than 8°C.

Borofibrists, p. 272

ABD. Other Fibrists that have a difference of less than 5°C between mean summer and mean winter soil temperatures at a depth of 30 cm from the soil surface.

Tropofibrists, p. 277

ABE. Other Fibrists that have a horizon 2 cm or more thick in which humilluvic materials constitute one half or more of the volume.

Luvifibrists, p. 274

ABF. Other Fibrists.

Medifibrists, p. 275

Borofibrists

Key to subgroups

ABCA. Borofibrists that have a layer of water within the control section below the surface tier.

Hydric Borofibrists

---

[4] Frozen 2 months after the summer solstice.

ABCB. Other Borofibrists that have a lithic contact within the control section.

Lithic Borofibrists

ABCC. Other Borofibrists which have *both*:

1. Three fourths or more of the fiber volume in the surface tier derived from *Sphagnum*; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Sphagnic Terric Borofibrists

ABCD. Other Borofibrists which have *both*:

1. One or more layers, with a total thickness of 25 cm or more, of the subsurface and bottom tiers consisting of hemic materials; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Hemic Terric Borofibrists

ABCE. Other Borofibrists which have *both*:

1. One or more layers, with a total thickness of 12.5 cm or more, of the subsurface and bottom tiers consisting of sapric materials; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Sapric Terric Borofibrists

ABCF. Other Borofibrists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Terric Borofibrists

ABCG. Other Borofibrists that have one or more limnic layers with a total thickness of 5 cm or more within the control section.

Limnic Borofibrists

ABCH. Other Borofibrists that have, within organic materials, either one mineral layer 5 cm or more thick, or two or more mineral layers of any thickness, in the control section below the surface tier.

Fluvaquentic Borofibrists

ABCI. Other Borofibrists that have three fourths or more of the fiber volume in the surface tier derived from *Sphagnum*.

Sphagnic Borofibrists

ABCJ. Other Borofibrists that have one or more layers, with a total thickness of 25 cm or more, of the subsurface and bottom tiers consisting of hemic materials.

Hemic Borofibrists

ABCK. Other Borofibrists that have one or more layers, with a total thickness of 12.5 cm or more, of the subsurface and bottom tiers consisting of sapric materials.

Sapric Borofibrists

ABCL. Other Borofibrists.

Typic Borofibrists

Cryofibrists

Key to subgroups

ABBA. Cryofibrists that have a lithic contact within the control section.

Lithic Cryofibrists

ABBB. Other Cryofibrists that have a mean annual soil temperature of 0°C or lower.

Pergelic Cryofibrists

ABBC. Other Cryofibrists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Terric Cryofibrists

ABBD. Other Cryofibrists that have, within organic materials, either one mineral layer 5 cm or more thick, or two or more mineral layers of any thickness, in the control section below the surface tier.

Fluvaquentic Cryofibrists

ABBE. Other Cryofibrists that have three fourths or more of the fiber volume in the surface tier derived from *Sphagnum*.

Sphagnic Cryofibrists

ABBF. Other Cryofibrists.

Typic Cryofibrists

Luvifibrists

Luvifibrists are not known to occur in the United States, but the great group is provided tentatively for use in other countries if needed. These soils are the Fibrists which have a horizon within the control section that is 2 cm or more thick and contains one half or more (by volume) humilluvic materials. Because these soils cannot be studied in the United States, a precise definition is not attempted here. It should be noted, however, that the soils are normally acid and that they have been cultivated for a long time.

Medifibrists

Key to subgroups

ABFA. Medifibrists that have a layer of water within the control section below the surface tier.

Hydric Medifibrists

ABFB. Other Medifibrists that have a lithic contact within the control section.

Lithic Medifibrists

ABFC. Other Medifibrists which have *both*:

1. Three fourths or more of the fiber volume in the surface tier derived from *Sphagnum*; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Sphagnic Terric Medifibrists

ABFD. Other Medifibrists which have *both*:

1. One or more layers, with a total thickness of 25 cm or more, of the subsurface and bottom tiers consisting of hemic materials; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Hemic Terric Medifibrists

ABFE. Other Medifibrists which have *both*:

1. One or more layers, with a total thickness of 12.5 cm or more, of the subsurface and bottom tiers consisting of sapric materials; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Sapric Terric Medifibrists

ABFF. Other Medifibrists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Terric Medifibrists

ABFG. Other Medifibrists that have one or more limnic layers with a total thickness of 5 cm or more within the control section.

Limnic Medifibrists

ABFH. Other Medifibrists that have, within organic materials, either one mineral layer 5 cm or more thick, or two or more mineral layers of any thickness, in the control section below the surface tier.

Fluvaquentic Medifibrists

ABFI. Other Medifibrists that have three fourths or more of the fiber volume in the surface tier derived from *Sphagnum*.

Sphagnic Medifibrists

ABFJ. Other Medifibrists that have one or more layers, with a total thickness of 25 cm or more, of the subsurface and bottom tiers consisting of hemic materials.

Hemic Medifibrists

ABFK. Other Medifibrists that have one or more layers, with a total thickness of 12.5 cm or more, of the subsurface and bottom tiers consisting of sapric materials.

Sapric Medifibrists

ABFL. Other Medifibrists.

Typic Medifibrists

Sphagnofibrists

Key to subgroups

ABAA. Sphagnofibrists which:

1. Have a mean annual soil temperature of 0°C or less; *and*

2. In most years, are *either* frozen in one or more layers within the control section 2 months after the summer solstice, *or* freeze to a depth of 5 cm or more below the soil surface.

Pergelic Sphagnofibrists

ABAB. Other Sphagnofibrists that have a layer of water within the control section below the surface tier.

Hydric Sphagnofibrists

ABAC. Other Sphagnofibrists that have a lithic contact within the control section.

Lithic Sphagnofibrists

ABAD. Other Sphagnofibrists which:

1. Have a mean annual soil temperature between 0°C and 8°C; *and*

2. In most years, are *either* frozen in one or more layers within the control section 2 months after the summer solstice, *or* freeze to a depth of 5 cm or more below the soil surface.

Cryic Sphagnofibrists

ABAE. Other Sphagnofibrists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Terric Sphagnofibrists

ABAF. Other Sphagnofibrists that have one or more limnic layers with a total thickness of 5 cm or more within the control section.

Limnic Sphagnofibrists

Cryofolists

Key to subgroups

AAAA. Cryofolists that have a lithic contact within 100 cm of the soil surface.

Lithic Cryofolists

AAAB. Other Cryofolists.

Typic Cryofolists

Medifolists

Key to subgroups

AADA. Medifolists that have a lithic contact within 100 cm of the soil surface.

Lithic Medifolists

AADB. Other Medifolists.

Typic Medifolists

Tropofolists

Key to subgroups

AABA. Tropofolists that have a lithic contact within 100 cm of the soil surface.

Lithic Tropofolists

AABB. Other Tropofolists.

Typic Tropofolists

HEMISTS

Key to great groups

ACA. Hemists which have a sulfuric horizon that has its upper boundary within 50 cm of the soil surface.

Sulfohemists, p. 283

ACB. Other Hemists that have sulfidic materials within 100 cm of the soil surface.

Sulfihemists, p. 283

ACC. Other Hemists that have a horizon 2 cm or more thick in which humilluvic materials constitute one half or more of the volume.

Luvihemists, p. 281

ACD. Other Hemists which, in most years, *either*:

1. Are frozen in one or more layers within the control section 2 months after the summer solstice; *or*

ACFG. Other Tropohemists that have, within organic materials, either one mineral layer 5 cm or more thick, or two or more mineral layers of any thickness, in the control section below the surface tier.

Fluvaquentic Tropohemists

ACFH. Other Tropohemists that have one or more layers, with a total thickness of 25 cm or more, of the subsurface and bottom tiers consisting of fibric materials.

Fibric Tropohemists

ACFI. Other Tropohemists that have one or more layers, with a total thickness of 12.5 cm or more, of the subsurface and bottom tiers consisting of sapric materials.

Sapric Tropohemists

ACFJ. Other Tropohemists.

Typic Tropohemists

SAPRISTS

Key to great groups

ADA. Saprists which have a sulfuric horizon that has its upper boundary within 50 cm of the soil surface.

Sulfosaprists, p. 287

ADB. Other Saprists that have sulfidic materials within 100 cm of the soil surface.

Sulfisaprists, p. 287

ADC. Other Saprists which, in most years, *either*:

1. Are frozen in one or more layers within the control section 2 months after the summer solstice; *or*

2. Never freeze below a depth of 5 cm from the soil surface but have a mean annual soil temperature lower than 8°C.

Cryosaprists, p. 286

ADD. Other Saprists that have a mean annual soil temperature lower than 8°C.

Borosaprists, p. 285

ADE. Other Saprists that have less than 5°C difference between mean summer and mean winter soil temperatures at a depth of 30 cm from the soil surface.

Troposaprists, p. 287

ADF. Other Saprists.

Medisaprists, p. 286

Borosaprists

Key to subgroups

ADDA. Borosaprists that have a lithic contact within the control section.

Lithic Borosaprists

ADDB. Other Borosaprists which have *both*:

1. One or more layers, with a total thickness of 12.5 cm or more, of the subsurface and bottom tiers consisting of fibric materials; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Fibric Terric Borosaprists

ADDC. Other Borosaprists which have *both*:

1. One or more layers, with a total thickness of 25 cm or more, of the subsurface and bottom tiers consisting of hemic materials; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Hemic Terric Borosaprists

ADDD. Other Borosaprists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Terric Borosaprists

ADDE. Other Borosaprists that have one or more limnic layers with a total thickness of 5 cm or more within the control section.

Limnic Borosaprists

ADDF. Other Borosaprists that have, within organic materials, either one mineral layer 5 cm or more thick, or two or more mineral layers of any thickness, in the control section below the surface tier.

Fluvaquentic Borosaprists

ADDG. Other Borosaprists that have one or more layers, with a total thickness of 12.5 cm or more, of the subsurface and bottom tiers consisting of fibric materials.

Fibric Borosaprists

ADDH. Other Borosaprists that have one or more layers, with a total thickness of 25 cm or more, of the subsurface and bottom tiers consisting of hemic materials.

Hemic Borosaprists

ADDI. Other Borosaprists.

Typic Borosaprists

Cryosaprists

Key to subgroups

ADCA. Cryosaprists that have a lithic contact within the control section.

Lithic Cryosaprists

ADCB. Other Cryosaprists that have a mean annual soil temperature of 0°C or lower.

Pergelic Cryosaprists

ADCC. Other Cryosaprists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Terric Cryosaprists

ADCD. Other Cryosaprists that have, within organic materials, either one mineral layer 5 cm or more thick, or two or more mineral layers of any thickness, in the control section below the surface tier.

Fluvaquentic Cryosaprists

ADCE. Other Cryosaprists.

Typic Cryosaprists

Medisaprists

Key to subgroups

ADDA. Medisaprists that have a lithic contact within the control section.

Lithic Medisaprists

ADFB. Other Medisaprists which have *both*:

1. One or more layers, with a total thickness of 12.5 cm or more, of the subsurface and bottom tiers consisting of fibric materials; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Fibric Terric Medisaprists

ADFC. Other Medisaprists which have *both*:

1. One or more layers, with a total thickness of 25 cm or more, of the subsurface and bottom tiers consisting of hemic materials; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Hemic Terric Medisaprists

ADFD. Other Medisaprists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Terric Medisaprists

ADFE. Other Medisaprists that have one or more limnic layers with a total thickness of 5 cm or more within the control section.

Limnic Medisaprists

ADFF. Other Medisaprists that have, within organic materials, either one mineral layer 5 cm or more thick, or two or more mineral layers of any thickness, in the control section below the surface tier.

Fluvaquentic Medisaprists

ADFG. Other Medisaprists that have one or more layers, with a total thickness of 12.5 cm or more, of the subsurface and bottom tiers consisting of fibric materials.

Fibric Medisaprists

ADFH. Other Medisaprists that have one or more layers, with a total thickness of 25 cm or more, of the subsurface and bottom tiers consisting of hemic materials.

Hemic Medisaprists

ADFI. Other Medisaprists.

Typic Medisaprists

Sulfisaprists

Key to subgroups

ADBA. Sulfisaprists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Terric Sulfisaprists

ADBB. Other Sulfisaprists.

Typic Sulfisaprists

Sulfosaprists

Key to subgroups

ADAA. All Sulfosaprists (provisionally).

Typic Sulfosaprists

Troposaprists

Key to subgroups

ADEA. Troposaprists that have a lithic contact within the control section.

Lithic Troposaprists

ADEB. Other Troposaprists which have *both*:

1. One or more layers, with a total thickness of 12.5 cm or more, of the subsurface and bottom tiers consisting of fibric materials; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Fibric Terric Troposaprists

ADEC. Other Troposaprists which have *both*:

1. One or more layers, with a total thickness of 25 cm or more, of the subsurface and bottom tiers consisting of hemic materials; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Hemic Terric Troposaprists

ADED. Other Troposaprists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Terric Troposaprists

ADEE. Other Troposaprists that have one or more limnic layers with a total thickness of 5 cm or more within the control section.

Limnic Troposaprists

ADEF. Other Troposaprists that have, within organic materials, either one mineral layer 5 cm or more thick, or two or more mineral layers of any thickness, in the control section below the surface tier.

Fluvaquentic Troposaprists

ADEG. Other Troposaprists that have one or more layers, with a total thickness of 12.5 cm or more, of the subsurface and bottom tiers consisting of fibric materials.

Fibric Troposaprists

ADEH. Other Troposaprists that have one or more layers, with a total thickness of 25 cm or more, of the subsurface and bottom tiers consisting of hemic materials.

Hemic Troposaprists

ADEI. Other Troposaprists.

Typic Troposaprists

Chapter 11

Inceptisols

KEY TO SUBORDERS

JA. Inceptisols which have:

1. Aquic conditions for some time in most years (or artificial drainage) in a layer between 40 and 50 cm from the mineral soil surface, *and one or more* of the following:

a. A histic epipedon; *or*

b. A sulfuric horizon that has its upper boundary within 50 cm of the mineral soil surface; *or*

c. A mollic, an ochric, or an umbric epipedon that is underlain directly, or within 50 cm of the mineral soil surface, by a horizon that has, on faces of peds or in the matrix if peds are absent, 50 percent or more chroma of *either*:

(1) Two or less if there are redox concentrations; *or*

(2) One or less; *or*

2. An exchangeable sodium percentage (ESP) of 15 or more (or a sodium adsorption ratio, SAR, of 13 or more) in half or more of the soil volume within 50 cm of the mineral soil surface, and a decrease in ESP (or SAR) values with increasing depth below 50 cm, *and* ground water within 100 cm of the mineral soil surface for some time during the year; *or*

3. Within 50 cm of the mineral soil surface, enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquepts, p. 290

JB. Other Inceptisols that have a plaggen epipedon.

Plaggepts, p. 320

JC. Other Inceptisols that have an isomesic or a warmer *iso* temperature regime.

Tropepts, p. 320

JD. Other Inceptisols that have *either*:

1. An ochric epipedon; *or*

2. A mesic or warmer soil temperature regime and an umbric or a mollic epipedon less than 25 cm thick.

Ochrepts, p. 301

JE. Other Inceptisols.

Umbrepts, p. 328

AQUEPTS

Key to great groups

JAA. Aquepts which have a sulfuric horizon that has its upper boundary within 50 cm of the mineral soil surface.

Sulfaquepts, p. 299

JAB. Other Aquepts that have, in half or more of each pedon, a placic horizon within 100 cm of the mineral soil surface.

Placaquepts, p. 298

JAC. Other Aquepts that have, in one or more horizons with a total thickness of 25 cm or more within 50 cm of the mineral soil surface, either an exchangeable sodium percentage (ESP) of 15 or more (or a sodium adsorption ratio, SAR, of 13 or more), and a decrease in ESP (or SAR) values with increasing depth below 50 cm.

Halaquepts, p. 296

JAD. Other Aquepts that have a fragipan.

Fragiaquepts, p. 295

JAE. Other Aquepts that have a cryic or pergelic soil temperature regime.

Cryaquepts, p. 291

JAF. Other Aquepts that have one or more horizons within 125 cm of the mineral soil surface in which plinthite either forms a continuous phase or constitutes one half or more of the volume.

Plinthaquepts, p. 299

JAG. Other Aquepts that have a difference of less than 5°C between mean summer and mean winter soil temperatures either at a depth of 50 cm from the soil surface, or at a lithic or paralithic contact, whichever is shallower.

Tropaquepts, p. 299

JAH. Other Aquepts that have a histic, a mollic, or an umbric epipedon.

Humaquepts, p. 297

JAI. Other Aquepts that have episaturation.

Epiaquepts, p. 294

JAJ. Other Aquepts.

Endoaquepts, p. 293

Cryaquepts

Key to subgroups

JAEA. Cryaquepts which have, within 150 cm of the mineral soil surface, *one or more* of the following:

1. A sulfuric horizon; *or*

2. A horizon 15 cm or more thick that has all the characteristics of a sulfuric horizon, except that it has a pH value between 3.5 and 4.0; *or*

3. Sulfidic materials.

Sulfic Cryaquepts

JAEB. Other Cryaquepts that have *both* a histic epipedon *and* a lithic contact within 50 cm of the mineral soil surface.

Histic Lithic Cryaquepts

JAEC. Other Cryaquepts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Cryaquepts

JAED. Other Cryaquepts which have *both*:

1. A histic epipedon that is continuous in each pedon; *and*

2. A mean annual soil temperature of 0°C or lower.

Histic Pergelic Cryaquepts

JAEE. Other Cryaquepts which have *both*:

1. A histic epipedon that is discontinuous in each pedon; *and*

2. A mean annual soil temperature of 0°C or lower.

Pergelic Ruptic-Histic Cryaquepts

JAEF. Other Cryaquepts which have *both*:

1. An umbric epipedon; *and*

2. A mean annual soil temperature of 0°C or lower.

Humic Pergelic Cryaquepts

JAEG. Other Cryaquepts that have a mean annual soil temperature of 0°C or lower.

Pergelic Cryaquepts

JAEH. Other Cryaquepts which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Cryaquepts

JAEI. Other Cryaquepts that have a histic epipedon.

Histic Cryaquepts

JAEJ. Other Cryaquepts which have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

3. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Aquandic Cryaquepts

JAEK. Other Cryaquepts that have *both*:

1. A chroma of 3 or more in 40 percent or more of the matrix of one or more horizons between 15 and 50 cm from the mineral soil surface; *and*

2. An umbric epipedon.

Aeric Humic Cryaquepts

JAEL. Other Cryaquepts that have a chroma of 3 or more in 40 percent or more of the matrix of one or more horizons between 15 and 50 cm from the mineral soil surface.

Aeric Cryaquepts

JAEM. Other Cryaquepts that have an umbric epipedon.

Humic Cryaquepts

JAEN. Other Cryaquepts.

Typic Cryaquepts

Endoaquepts

Key to subgroups

JAJA. Endoaquepts which have, within 150 cm of the mineral soil surface, *one or more* of the following:

1. A sulfuric horizon; *or*

2. A horizon 15 cm or more thick that has all the characteristics of a sulfuric horizon, except that it has a pH value between 3.5 and 4.0; *or*

3. Sulfidic materials.

Sulfic Endoaquepts

JAJB. Other Endoaquepts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Endoaquepts

JAJC. Other Endoaquepts which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Endoaquepts

JAJD. Other Endoaquepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

3. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Aquandic Endoaquepts

JAJE. Other Endoaquepts that have, in one or more horizons between the A or Ap horizon and a depth of 75 cm below the mineral soil surface, *one* of the following colors:

1. A hue of 7.5YR or redder in 50 percent or more of the matrix, *and*

a. If peds are present, either a chroma of 2 or more on 50 percent or more of ped exteriors, or no redox depletions with a chroma of 2 or less in ped interiors; *or*

b. If peds are absent, a chroma of 2 or more in 50 percent or more of the matrix; *or*

2. In 50 percent or more of the matrix, a hue of 10YR or yellower *and either*

a. Both a color value, moist, and chroma of 3 or more; *or*

b. A chroma of 2 or more if there are no redox concentrations.

Aeric Endoaquepts

JAJF. Other Endoaquepts which have:

1. An Ap horizon, or an A horizon 15 cm or more thick, with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample); *and*

2. A base saturation (by NH_4OAc) of less than 50 percent that does not increase with depth to 50 percent or more within 100 cm of the mineral soil surface.

Humic Endoaquepts

JAJG. Other Endoaquepts that have an Ap horizon, or an A horizon 15 cm or more thick, with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample).

Mollic Endoaquepts

JAJH. Other Endoaquepts.

Typic Endoaquepts

Epiaquepts

Key to subgroups

JAIA. Epiaquepts which have *one or both* of the following:

JADC. Other Fragiaquepts.

Typic Fragiaquepts

Halaquepts

Key to subgroups

JACA. Halaquepts which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Halaquepts

JACB. Other Halaquepts which have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

3. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

   a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

   b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Aquandic Halaquepts

JACC. Other Halaquepts that have a chroma of 3 or more in 40 percent or more of the matrix of one or more horizons between 15 and 75 cm from the mineral soil surface.

Aeric Halaquepts

JACD. Other Halaquepts that have a mollic epipedon.

Mollic Halaquepts

JACE. Other Halaquepts.

Typic Halaquepts

Humaquepts

Key to subgroups

JAHA. Humaquepts that have an *n* value *either* of 0.7 or more in one or more layers between 20 and 50 cm from the mineral soil surface, *or* of 0.9 or more in one or more layers between 50 and 80 cm.

Hydraquentic Humaquepts

JAHB. Other Humaquepts which have a histic epipedon.

Histic Humaquepts

JAHC. Other Humaquepts which have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

3. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

   a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

   b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Aquandic Humaquepts

JAHD. Other Humaquepts which have *both*:

1. An epipedon 60 cm or more thick; *and*

2. *Either* 0.2 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a lithic or paralithic contact if shallower.

Cumulic Humaquepts

JAHE. Other Humaquepts that have *either* 0.2 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a lithic or paralithic contact if shallower.

Fluvaquentic Humaquepts

JAHF. Other Humaquepts that have a hue of 5Y or redder and a chroma of 3 or more in more than 40 percent of the matrix of one or more subhorizons between 15 and 75 cm from the mineral soil surface.

Aeric Humaquepts

JAHG. Other Humaquepts.

Typic Humaquepts

Placaquepts

Key to subgroups

JABA. Placaquepts that have a histic epipedon.

Histic Placaquepts

JABB. Other Placaquepts which have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

3. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Aquandic Placaquepts

JABC. Other Placaquepts that do not, within 100 cm of the mineral soil surface, have a continuous placic horizon in each pedon.

Haplic Placaquepts

JABD. Other Placaquepts.

Typic Placaquepts

Plinthaquepts

Plinthaquepts occur mainly in tropical regions. They have one or more horizons within 125 cm of the mineral soil surface in which plinthite either forms a continuous phase or constitutes one half or more of the volume. These are soils in which the groundwater table fluctuates considerably during the year, between a level at or near the soil surface during the rainy season and a much lower level during the dry season. Most of the soils have developed in relatively recent alluvial deposits, probably of late-Pleistocene or Holocene age, and contain appreciable amounts of weatherable minerals. Plinthaquepts are not known to occur in the United States, but the great group is provided because these soils are thought to be extensive in parts of the Amazon Basin.

Sulfaquepts

Key to subgroups

JAAA. Sulfaquepts that have a salic horizon within 75 cm of the mineral soil surface.

Salorthidic Sulfaquepts

JAAB. Other Sulfaquepts that have *both*:

1. An *n* value of more than 0.7; *and*

2. Eight percent or more clay in the fine-earth fraction of all horizons between 20 and 50 cm from the mineral soil surface.

Hydraquentic Sulfaquepts

JAAC. Other Sulfaquepts.

Typic Sulfaquepts

Tropaquepts

Key to subgroups

JAGA. Tropaquepts which have, within 150 cm of the mineral soil surface, *one or more* of the following:

1. A sulfuric horizon; *or*

2. A horizon 15 cm or more thick that has all the characteristics of a sulfuric horizon, except that it has a pH value between 3.5 and 4.0; *or*

3. Sulfidic materials.

Sulfic Tropaquepts

JAGB. Other Tropaquepts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Tropaquepts

2. A hue of 2.5Y or redder, a color value, moist, of 5 or less, and a chroma of 2 or more; *or*

3. A hue of 5Y and a chroma of 3 or more; *or*

4. A chroma of 2 or more if there are no redox concentrations.

Aeric Tropaquepts

JAGH. Other Tropaquepts.

Typic Tropaquepts

OCHREPTS

Key to great groups

JDA. Ochrepts that have a sulfuric horizon within 50 cm of the mineral soil surface.

Sulfochrepts, p. 311

JDB. Other Ochrepts that have a fragipan.

Fragiochrepts, p. 310

JDC. Other Ochrepts which have a duripan that has its upper boundary within 100 cm of the mineral soil surface.

Durochrepts, p. 303

JDD. Other Ochrepts that have a cryic or pergelic soil temperature regime.

Cryochrepts, p. 301

JDE. Other Ochrepts that have an ustic moisture regime.

Ustochrepts, p. 311

JDF. Other Ochrepts that have a xeric moisture regime.

Xerochrepts, p. 317

JDG. Other Ochrepts that have *one or both* of the following:

I N C

1. Carbonates within the soil; *or*

2. A base saturation (by NH_4OAc) of 60 percent or more in one or more horizons between 25 and 75 cm from the mineral soil surface.

Eutrochrepts, p. 307

JDH. Other Ochrepts.

Dystrochrepts, p. 304

Cryochrepts

Key to subgroups

JDDA. Cryochrepts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Cryochrepts

Durochrepts

Key to subgroups

JDCA. Durochrepts which have *both*:

1. In one or more horizons within 30 cm of the mineral soil surface, distinct or prominent redox concentrations, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

a. A fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

b. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

c. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

(1) In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

(2) In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Aquandic Durochrepts

JDCB. Other Durochrepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Durochrepts

JDCC. Other Durochrepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

2. An argillic horizon in less than half of each pedon.

Lithic Ruptic-Ultic Dystrochrepts

JDHC. Other Dystrochrepts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Dystrochrepts

JDHD. Other Dystrochrepts which have *both*:

1. In one or more horizons within 60 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

a. A fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

b. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

c. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

(1) In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

(2) In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Aquandic Dystrochrepts

JDHE. Other Dystrochrepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Dystrochrepts

JDHF. Other Dystrochrepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66

percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Vitrandic Dystrochrepts

JDHG. Other Dystrochrepts which have:

1. In one or more horizons within 60 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. *Either* 0.2 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a lithic or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.

Fluvaquentic Dystrochrepts

JDHH. Other Dystrochrepts that have, in one or more horizons within 60 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Dystrochrepts

JDHI. Other Dystrochrepts that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Dystrochrepts

JDHJ. Other Dystrochrepts which have:

1. *Either* 0.2 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a lithic or paralithic contact if shallower; *and*

2. A slope of less than 25 percent; *and*

3. An Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample), or materials between the soil surface and a depth of 18 cm which have these color values after mixing.

Fluventic Umbric Dystrochrepts

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Eutrochrepts

JDGD. Other Eutrochrepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Eutrochrepts

JDGE. Other Eutrochrepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Vitrandic Eutrochrepts

JDGF. Other Eutrochrepts that have anthraquic conditions.

Anthraquic Eutrochrepts

JDGG. Other Eutrochrepts that have:

1. In one or more horizons within 60 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. *Either* 0.2 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a lithic or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.

Fluvaquentic Eutrochrepts

JDGH. Other Eutrochrepts which:

1. Have, in one or more horizons within 60 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. Do not, in each pedon, have carbonates in all horizons within 100 cm of the mineral soil surface.

Aquic Dystric Eutrochrepts

JDGI. Other Eutrochrepts that have, in one or more horizons within 60 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Eutrochrepts

JDGJ. Other Eutrochrepts that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Eutrochrepts

JDGK. Other Eutrochrepts which:

1. Do not, in each pedon, have carbonates in all horizons within 100 cm of the mineral soil surface; *and*

2. Have *either* 0.2 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a lithic or paralithic contact if shallower; *and*

3. Have a slope of less than 25 percent.

Dystric Fluventic Eutrochrepts

JDGL. Other Eutrochrepts which have *both*:

1. *Either* 0.2 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a lithic or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.

Fluventic Eutrochrepts

JDGM. Other Eutrochrepts that have a sandy particle size in all horizons within 50 cm of the mineral soil surface.

Arenic Eutrochrepts

JDGN. Other Eutrochrepts that do not, in each pedon, have carbonates in all horizons within 100 cm of the mineral soil surface.

Dystric Eutrochrepts

JDGO. Other Eutrochrepts that have 40 percent or more carbonates, including coarse fragments up to 75 mm in

Sulfochrepts

Key to subgroups

JDAA. All Sulfochrepts (provisionally).

Typic Sulfochrepts

Ustochrepts

Key to subgroups

JDEA. Ustochrepts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Ustochrepts

JDEB. Other Ustochrepts which have *both*:

1. If neither irrigated nor fallowed to store moisture, *one* of the following:

   a. A frigid soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 105 cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   b. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for less than four tenths of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   c. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C; *and*

2. *One or both* of the following:

   a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

   b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Udertic Ustochrepts

JDEC. Other Ustochrepts which have *both*:

b. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

c. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is moist in some or all parts for less than 180 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Torrifluventic Ustochrepts

JDEJ. Other Ustochrepts which have:

1. *Either* 0.2 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a lithic or paralithic contact if shallower; *and*

2. A slope of less than 25 percent; *and*

3. If neither irrigated nor fallowed to store moisture, *one* of the following:

a. A frigid soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 105 cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

b. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for less than four tenths of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

c. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Udifluventic Ustochrepts

JDEK. Other Ustochrepts which have *both*:

1. *Either* 0.2 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a lithic or paralithic contact if shallower; *and*

years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Calcic Udic Ustochrepts

JDEN. Other Ustochrepts which have a calcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Calcic Ustochrepts

JDEO. Other Ustochrepts which, if neither irrigated nor fallowed to store moisture, have *one* of the following:

1. A frigid soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in all parts for four tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

3. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is moist in some or all parts for less than 180 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Aridic Ustochrepts

JDEP. Other Ustochrepts that have a base saturation (by sum of cations) of less than 60 percent in all horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 75 cm or a lithic or paralithic contact, whichever is shallower.

Dystric Ustochrepts

JDEQ. Other Ustochrepts which, if neither irrigated nor fallowed to store moisture, have *one* of the following:

1. A frigid soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 105 cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for less than four tenths of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Vitrandic Xerochrepts

JDFJ. Other Xerochrepts that have a gypsic horizon within 100 cm of the mineral soil surface.

Gypsic Xerochrepts

JDFK. Other Xerochrepts that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. A base saturation (by NH_4OAc) of less than 60 percent in all horizons between 25 and 75 cm from the mineral soil surface.

Aquic Dystric Xerochrepts

JDFL. Other Xerochrepts that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Xerochrepts

JDFM. Other Xerochrepts which have:

1. A base saturation (by NH_4OAc) of less than 60 percent in all horizons between 25 and 75 cm from the mineral soil surface; *and*

2. *Either* 0.2 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a lithic or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.

Dystric Fluventic Xerochrepts

JDFN. Other Xerochrepts which have *both*:

1. *Either* 0.2 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a lithic or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.

Fluventic Xerochrepts

JDFO. Other Xerochrepts that have a base saturation (by NH_4OAc) of less than 60 percent in all horizons between 25 and 75 cm from the mineral soil surface.

Dystric Xerochrepts

JDFP. Other Xerochrepts that have a calcic horizon or soft powdery lime, either within the following depths or above a lithic or paralithic contact if shallower, if the particle-size control section is

1. Sandy: within 150 cm of the mineral soil surface; *or*

2. Loamy: within 110 cm of the mineral soil surface; *or*

3. Clayey: within 90 cm of the mineral soil surface.

Calcixerollic Xerochrepts

JDFQ. Other Xerochrepts.

Typic Xerochrepts

PLAGGEPTS

Plaggepts are the soils that have a plaggen epipedon. Because Plaggepts are not known to occur in the United States, their classification has not been developed beyond the idea that they should be grouped into a single suborder.

TROPEPTS

Key to great groups

JCA. Tropepts which:

1. Have a base saturation of less than 50 percent (by NH_4OAc) in one or more horizons between 25 and 100 cm from the mineral soil surface; *and*

2. Have 12 kg/m² or more organic carbon between the mineral soil surface and either a depth of 100 cm or a lithic, paralithic, or petroferric contact, whichever is shallower; *and*

3. Do not have a sombric horizon.

Humitropepts, p. 325

JCB. Other Tropepts that have a sombric horizon.

Sombritropepts, p. 327

JCC. Other Tropepts that have *both*:

1. An ustic moisture regime; *and*

2. A base saturation (by NH_4OAc) of 50 percent or more in all horizons between a depth of 25 cm from the mineral soil surface and either a depth of 100 cm, or a lithic, paralithic, or petroferric contact if shallower.

Ustropepts, p. 327

JCD. Other Tropepts that have a base saturation (by NH_4OAc) of 50 percent or more in all horizons between a depth of 25 cm from the mineral soil surface and either a depth of 100 cm, or a lithic, paralithic, or petroferric contact if shallower.

Eutropepts, p. 323

JCE. Other Tropepts.

Dystropepts, p. 321

Dystropepts

Key to subgroups

JCEA. Dystropepts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Dystropepts

JCEB. Other Dystropepts that have a petroferric contact within 50 cm of the mineral soil surface.

Petroferric Dystropepts

JCEC. Other Dystropepts which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Dystropepts

JCED. Other Dystropepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Dystropepts

JCEE. Other Dystropepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Vitrandic Dystropepts

JCEF. Other Dystropepts that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Dystropepts

JCEG. Other Dystropepts that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Dystropepts

JCEH. Other Dystropepts which have *both*:

1. *Either* 0.2 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a lithic or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.

Fluventic Dystropepts

JCEI. Other Dystropepts that have *both*:

1. An ustic moisture regime; *and*

2. A CEC (by 1N NH_4OAc pH 7) of less than 24 cmol(+)/kg clay[1] in 50 percent or more of the soil volume between a depth of 25 cm from the mineral soil surface and either a depth of 100 cm, or a lithic or paralithic contact if shallower.

Ustoxic Dystropepts

JCEJ. Other Dystropepts that have a CEC (by 1N NH_4OAc pH 7) of less than 24 cmol(+)/kg clay[2] in 50 percent or more of the soil volume between a depth of 25 cm from the mineral soil surface and either a depth of 100 cm, or a lithic or paralithic contact if shallower.

Oxic Dystropepts

JCEK. Other Dystropepts that have an ustic moisture regime.

Ustic Dystropepts

---

[1] Some cambic horizons with properties that approach those of an oxic horizon do not disperse well. If the ratio of (percent water retained at 1500 kPa tension minus percent organic carbon) to the percentage of measured clay in the fine-earth fraction is 0.6 or more, then the percentage of clay is considered to equal either (1) the measured percentage of clay, or (2) three times (percent water retained at 1500 kPa tension minus percent organic carbon), whichever value is higher, but no more than 100.

[2] See footnote 1.

JCEL. Other Dystropepts.

Typic Dystropepts

Eutropepts

Key to subgroups

JCDA. Eutropepts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Eutropepts

JCDB. Other Eutropepts which have *both*:

1. *One or both* of the following:

    a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

    b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower; *and*

2. In one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquertic Eutropepts

JCDC. Other Eutropepts which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Eutropepts

JCDD. Other Eutropepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Eutropepts

JCDE. Other Eutropepts that have, throughout one or more horizons with a total thickness of 18 cm or more

within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Vitrandic Eutropepts

JCDF. Other Eutropepts that have:

1. In one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. *Either* 0.2 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a lithic or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.

Fluvaquentic Eutropepts

JCDG. Other Eutropepts that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Eutropepts

JCDH. Other Eutropepts that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Eutropepts

JCDI. Other Eutropepts which have *both*:

1. *Either* 0.2 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a lithic or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.

Fluventic Eutropepts

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Ustandic Humitropepts

JCAE. Other Humitropepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Humitropepts

JCAF. Other Humitropepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Vitrandic Humitropepts

JCAG. Other Humitropepts that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Humitropepts

JCAH. Other Humitropepts that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Humitropepts

JCAI. Other Humitropepts which have *both*:

1. An organic-carbon content that decreases irregularly with increasing depth to the lower boundary of the cambic horizon; *and*

years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Ustropepts

JCCC. Other Ustropepts that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Ustropepts

JCCD. Other Ustropepts that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Ustropepts

JCCE. Other Ustropepts that have a CEC (by 1N NH_4OAc pH 7) of less than 24 cmol(+)/kg clay[5] in 50 percent or more of the soil volume between a depth of 25 cm from the mineral soil surface and either a depth of 100 cm, or a lithic or paralithic contact if shallower.

Oxic Ustropepts

JCCF. Other Ustropepts which have *both*:

1. *Either* 0.2 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a lithic or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.

Fluventic Ustropepts

JCCG. Other Ustropepts.

Typic Ustropepts

UMBREPTS

Key to great groups

JEA. Umbrepts that have a fragipan.

Fragiumbrepts, p. 330

JEB. Other Umbrepts that have a cryic or pergelic soil temperature regime.

Cryumbrepts, p. 329

---

[5] See footnote 3.

b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Vitrandic Cryumbrepts

JEBG. Other Cryumbrepts that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Cryumbrepts

JEBH. Other Cryumbrepts that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Cryumbrepts

JEBI. Other Cryumbrepts that do not have a cambic horizon.

Entic Cryumbrepts

JEBJ. Other Cryumbrepts.

Typic Cryumbrepts

Fragiumbrepts

<u>Key to subgroups</u>

JEAA. Fragiumbrepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Fragiumbrepts

JEAB. Other Fragiumbrepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron

percentages (by ammonium oxalate) totaling 0.40 or more.

Vitrandic Fragiumbrepts

JEAC. Other Fragiumbrepts that have, in one or more horizons within 50 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Fragiumbrepts

JEAD. Other Fragiumbrepts.

Typic Fragiumbrepts

Haplumbrepts

Key to subgroups

JEDA. Haplumbrepts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haplumbrepts

JEDB. Other Haplumbrepts that have *both*:

1. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *and*

2. In one or more horizons within 50 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquandic Haplumbrepts

JEDC. Other Haplumbrepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Haplumbrepts

JEDD. Other Haplumbrepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Vitrandic Haplumbrepts

JEDE. Other Haplumbrepts that have, in all horizons within 100 cm of the mineral soil surface, *both*:

1. A sandy particle size; *and*

2. More than 90 percent silica and other extremely durable minerals in the 0.02-to-2.0-mm fraction.

Quartzipsammentic Haplumbrepts

JEDF. Other Haplumbrepts that have a sandy particle size in all horizons within 100 cm of the mineral soil surface.

Psammentic Haplumbrepts

JEDG. Other Haplumbrepts which have:

1. An umbric or a mollic epipedon that is 50 cm or more thick; *and*

2. An irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a lithic or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.

Cumulic Haplumbrepts

JEDH. Other Haplumbrepts that have an umbric or a mollic epipedon that is 50 cm or more thick.

Pachic Haplumbrepts

JEDI. Other Haplumbrepts that have, in one or more horizons within 50 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Haplumbrepts

JEDJ. Other Haplumbrepts that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Haplumbrepts

JEDK. Other Haplumbrepts which have *both*:

1. An irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a lithic or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.

Fluventic Haplumbrepts

JEDL. Other Haplumbrepts that do not have a cambic horizon.

Entic Haplumbrepts

JEDM. Other Haplumbrepts.

Typic Haplumbrepts

Xerumbrepts

Key to subgroups

JECA. Xerumbrepts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Xerumbrepts

JECB. Other Xerumbrepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Xerumbrepts

JECC. Other Xerumbrepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

    a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

    b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Vitrandic Xerumbrepts

JECD. Other Xerumbrepts that have an umbric or a mollic epipedon that is 50 cm or more thick.

Pachic Xerumbrepts

JECE. Other Xerumbrepts that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Xerumbrepts

JECF. Other Xerumbrepts which have *both*:

1. An irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a lithic or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.

Fluventic Xerumbrepts

JECG. Other Xerumbrepts that do not have a cambic horizon.

Entic Xerumbrepts

JECH. Other Xerumbrepts.

Typic Xerumbrepts

Chapter 12

Mollisols

KEY TO SUBORDERS

HA. Mollisols that have:

1. An argillic or a natric horizon; *and*

2. An albic horizon with a chroma of 2 or less that is 2.5 cm or more thick, has its lower boundary 18 cm or more below the mineral soil surface, and either lies directly below the mollic epipedon or separates horizons that together meet all the requirements for a mollic epipedon; *and*

3. In one or more subhorizons of the albic and/or the argillic or natric horizon and within 100 cm of the mineral soil surface, redox concentrations in the form of masses or concretions or both, and also aquic conditions for some time in most years (or artificial drainage).

Albolls, p. 337

HB. Other Mollisols which have aquic conditions for some time in most years (or artificial drainage) between 40 and 50 cm from the mineral soil surface, *and one or more* of the following:

1. A histic epipedon overlying the mollic epipedon; *or*

2. An exchangeable sodium percentage (ESP) of 15 or more (or a sodium adsorption ratio, SAR, of 13 or more) in the upper part of the mollic epipedon, and a decrease in ESP (or SAR) values with increasing depth below 50 cm from the mineral soil surface; *or*

3. A calcic or petrocalcic horizon that has its upper boundary within 40 cm of the mineral soil surface; *or*

4. *One* of the following colors:

a. A chroma of 1 or less in the lower part of the mollic epipedon[1], *and either*

(1) Distinct or prominent redox concentrations in the lower part of the mollic epipedon; *or*

(2) Either directly below the mollic epipedon, or within 75 cm of the mineral soil surface if a calcic horizon

---

[1] If the mollic epipedon extends to a lithic contact within 30 cm of the mineral soil surface, the requirement for redoximorphic features is waived.

intervenes, a color value, moist, of 4 or more *and one* of the following:

(a) Fifty percent or more chroma of 1 on faces of peds or in the matrix, a hue of 10YR or redder, and redox concentrations; *or*

(b) Fifty percent or more chroma of 2 or less on faces of peds or in the matrix, a hue of 2.5Y, and redox concentrations; *or*

(c) Fifty percent or more chroma of 1 on faces of peds or in the matrix, and a hue of 2.5Y or yellower; *or*

(d) Fifty percent or more chroma of 3 or less on faces of peds or in the matrix, a hue of 5Y, and redox concentrations; *or*

(e) Fifty percent or more chroma of 0 on faces of peds or in the matrix; *or*

(f) A hue of 5GY, 5G, 5BG, or 5B; *or*

(g) Any color if it results from uncoated sand grains; *or*

b. A chroma of 2 in the lower part of the mollic epipedon, *and either*

(1) Distinct or prominent redox concentrations in the lower part of the mollic epipedon; *or*

(2) Directly below the mollic epipedon, *one* of the following matrix colors:

(a) A color value, moist, of 4, a chroma of 2, and some redox depletions with a color value, moist, of 4 or more and a chroma of 1 or less; *or*

(b) A color value, moist, of 5 or more, a chroma of 2 or less, and redox concentrations; *or*

(c) A color value, moist, of 4 and a chroma of 1 or less; *or*

5. Between 40 and 50 cm from the mineral soil surface, enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquolls, p. 339

HC. Other Mollisols which:

1. Have a mollic epipedon less than 50 cm thick; *and*

2. Do not have an argillic or a calcic horizon; *and*

3. Have, either within or directly below the mollic epipedon, mineral soil materials less than 7.5 cm in diameter that have a $CaCO_3$ equivalent of 40 percent or more; *and*

4. Have either a udic moisture regime or a cryic soil temperature regime.

Rendolls, p. 363

HD. Other Mollisols that have either a xeric moisture regime or an aridic moisture regime bordering on a xeric regime, but do not have a cryic soil temperature regime.

Xerolls, p. 394

HE. Other Mollisols that have a frigid, cryic, or pergelic soil temperature regime.

Borolls, p. 346

HF. Other Mollisols that have either an ustic moisture regime, or an aridic moisture regime that borders on an ustic regime.

Ustolls, p. 373

HG. Other Mollisols.

Udolls, p. 364

ALBOLLS

Key to great groups

HAA. Albolls that have a natric horizon.

Natralbolls, p. 339

HAB. Other Albolls.

Argialbolls, p. 337

Argialbolls

Key to subgroups

HABA. Argialbolls which have *both*:

1. *One or both* of the following:

a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either

a depth of 100 cm or a lithic or paralithic contact, whichever is shallower; *and*

2. If not irrigated, a moisture control section which, in 6 or more out of 10 years, is dry in all parts for 45 or more consecutive days during the 120 days following the summer solstice.

Xerertic Argialbolls

HABB. Other Argialbolls which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Argialbolls

HABC. Other Argialbolls which:

1. Do not have an abrupt textural change from the albic to the argillic horizon; *and*

2. If not irrigated, have a moisture control section which, in 6 or more out of 10 years, is dry in all parts for 45 or more consecutive days during the 120 days following the summer solstice.

Argiaquic Xeric Argialbolls

HABD. Other Argialbolls that do not have an abrupt textural change from the albic to the argillic horizon.

Argiaquic Argialbolls

HABE. Other Argialbolls which, if not irrigated, have a moisture control section which, in 6 or more out of 10 years, is dry in all parts for 45 or more consecutive days during the 120 days following the summer solstice.

Xeric Argialbolls

HABF. Other Argialbolls which have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

3. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Aquandic Argialbolls

HABG. Other Argialbolls.

Typic Argialbolls

Natralbolls

Key to subgroups

HAAA. All Natralbolls (provisionally).

Typic Natralbolls

AQUOLLS

Key to great groups

HBA. Aquolls that have a cryic or pergelic soil temperature regime.

Cryaquolls, p. 341

HBB. Other Aquolls which have a duripan that has its upper boundary within 100 cm of the mineral soil surface.

Duraquolls, p. 342

HBC. Other Aquolls that have a natric horizon.

Natraquolls, p. 345

HBD. Other Aquolls which have a calcic or gypsic horizon that has its upper boundary within 40 cm of the mineral soil surface, but do not have an argillic horizon unless it is a buried horizon.

Calciaquolls, p. 340

HBE. Other Aquolls that have an argillic horizon.

Argiaquolls, p. 340

HBF. Other Aquolls that have episaturation.

Epiaquolls, p. 344

HBG. Other Aquolls.

Endoaquolls, p. 342

b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Aquandic Cryaquolls

HBAF. Other Cryaquolls that have an argillic horizon.

Argic Cryaquolls

HBAG. Other Cryaquolls that have a calcic horizon either within or directly below the mollic epipedon.

Calcic Cryaquolls

HBAH. Other Cryaquolls that have a mollic epipedon 50 cm or more thick.

Cumulic Cryaquolls

HBAI. Other Cryaquolls.

Typic Cryaquolls

Duraquolls

Key to subgroups

HBBA. Duraquolls that have a natric horizon.

Natric Duraquolls

HBBB. Other Duraquolls which have, above the duripan, *one or both* of the following:

1. Cracks that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick; *or*

2. A linear extensibility of 6.0 cm or more.

Vertic Duraquolls

HBBC. Other Duraquolls that have an argillic horizon.

Argic Duraquolls

HBBD. Other Duraquolls.

Typic Duraquolls

Endoaquolls

Key to subgroups

HBGA. Endoaquolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Endoaquolls

HBGB. Other Endoaquolls which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has

cm, or to a lithic or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.

Fluvaquentic Endoaquolls

HBGI. Other Endoaquolls.

Typic Endoaquolls

Epiaquolls

Key to subgroups

HBFA. Epiaquolls that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Epiaquolls

HBFB. Other Epiaquolls that have a histic epipedon.

Histic Epiaquolls

HBFC. Other Epiaquolls which have a buried Histosol that has its upper boundary within 100 cm of the mineral soil surface.

Thapto-Histic Epiaquolls

HBFD. Other Epiaquolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

3. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*

a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron

BOROLLS

Key to great groups

HEA. Borolls which have *both*:

1. An argillic horizon that has its upper boundary 60 cm or more below the mineral soil surface; *and*

2. A texture finer than loamy fine sand in all horizons above the argillic horizon.

Paleborolls, p. 361

HEB. Other Borolls that have a cryic or pergelic soil temperature regime.

Cryoborolls, p. 352

HEC. Other Borolls which have a natric horizon, but do not have a cambic horizon that is above the natric horizon and separated from it by an albic horizon.

Natriborolls, p. 360

HED. Other Borolls which have an argillic horizon, but do not have a cambic horizon that is above the argillic horizon and separated from it by an albic horizon.

Argiborolls, p. 347

HEE. Other Borolls that have a mollic epipedon which:

1. Either below an Ap horizon or below a depth of 18 cm from the mineral soil surface, contains 50 percent or more (by volume) wormholes, worm casts, or filled animal burrows; *and*

2. Either rests on a lithic contact, or has a transition zone to the underlying horizon in which 25 percent or more of the soil volume consists of discrete wormholes, worm casts, or animal burrows filled with material from the mollic epipedon and from the underlying horizon.

Vermiborolls, p. 363

HEF. Other Borolls which:

1. Have a calcic or petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface; *and*

2. In all parts above the calcic or petrocalcic horizon, after the materials between the soil surface and a depth of 18 cm have been mixed, are either calcareous or have a texture of loamy fine sand or coarser.

Calciborolls, p. 351

HEG. Other Borolls.

Haploborolls, p. 356

Argiborolls

Key to subgroups

HEDA. Argiborolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Argiborolls

HEDB. Other Argiborolls that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm or more below the mineral soil surface.

Arenic Argiborolls

HEDC. Other Argiborolls which have:

1. An argillic horizon that has a clay increase with depth of 20 percent or more (absolute, in the fine-earth fraction) within its upper 7.5 cm; *and*

2. A color value, dry, of 5 or more either in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick; *and*

3. A moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C.

Abruptic Aridic Argiborolls

HEDD. Other Argiborolls which have *both*:

1. An argillic horizon that has a clay increase with depth of 20 percent or more (absolute, in the fine-earth fraction) within its upper 7.5 cm; *and*

2. *Either* a chroma of 1 or less (crushed and smoothed sample) in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick, *or* a moisture control section that is moist in some or all of its parts throughout the year in 6 or more out of 10 years.

Abruptic Udic Argiborolls

HEDE. Other Argiborolls which have an argillic horizon that has a clay increase with depth of 20 percent or more (absolute, in the fine-earth fraction) within its upper 7.5 cm.

Abruptic Argiborolls

HEDF. Other Argiborolls which have *both*:

1. *One or both* of the following:

a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years and slick [illegible]

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Argiborolls

HEDI. Other Argiborolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Argiborolls

HEDJ. Other Argiborolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Vitrandic Argiborolls

HEDK. Other Argiborolls which have *both*:

1. A mollic epipedon 40 cm or more thick with a texture finer than loamy fine sand; *and*

2. *Either* a chroma of 1 or less (crushed and smoothed sample) in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick, *or* a moisture control section that is moist in some or all of its parts throughout the year in 6 or more out of 10 years.

Pachic Udic Argiborolls

HEDL. Other Argiborolls that have a mollic epipedon 40 cm or more thick with a texture finer than loamy fine sand.

Pachic Argiborolls

HEDM. Other Argiborolls which have *both*:

1. A color value, dry, of 5 or more either in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick; *and*

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Argic Vertic Cryoborolls

HEBI. Other Cryoborolls which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Cryoborolls

HEBJ. Other Cryoborolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Cryoborolls

HEBK. Other Cryoborolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Vitrandic Cryoborolls

HEBL. Other Cryoborolls which have a duripan that has its upper boundary within 100 cm of the mineral soil surface.

Duric Cryoborolls

HEBM. Other Cryoborolls which have *both*:

1. An albic horizon directly below the mollic epipedon; *and*

2. An argillic horizon that has a clay increase with depth of 20 percent or more (absolute, in the fine-earth fraction) within its upper 7.5 cm.

Abruptic Cryoborolls

HEBN. Other Cryoborolls which have an argillic horizon, *and either*:

1. Above the argillic horizon, an albic horizon, *or* a horizon that has color values too high for a mollic epipedon and a chroma too high for an albic horizon; *or*

2. A glossic horizon, *or* interfingering of albic materials into the upper part of the argillic horizon, *or* skeletans of clean silt and sand covering 50 percent or more of the faces of peds in the upper 5 cm of the argillic horizon.

Boralfic Cryoborolls

HEBO. Other Cryoborolls which have:

1. A mollic epipedon 40 cm or more thick with a texture finer than loamy fine sand; *and*

2. An irregular decrease in organic-carbon content from a depth of 25 cm below the mineral soil surface to a depth of 125 cm, or to a lithic or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.

Cumulic Cryoborolls

HEBP. Other Cryoborolls which have *both*:

1. A mollic epipedon 40 cm or more thick with a texture finer than loamy fine sand; *and*

2. A calcic horizon either within or directly below the mollic epipedon, but *no* argillic horizon in the lower part of the mollic epipedon.

Calcic Pachic Cryoborolls

HEBQ. Other Cryoborolls that have *both*:

1. An argillic horizon; *and*

HEBY. Other Cryoborolls that have a calcic horizon either within or directly below the mollic epipedon.

Calcic Cryoborolls

HEBZ. Other Cryoborolls that have an albic horizon directly below the mollic epipedon.

Albic Cryoborolls

HEBZa. Other Cryoborolls.

Typic Cryoborolls

Haploborolls

Key to subgroups

HEGA. Haploborolls which have a salic horizon that has its upper boundary within 75 cm of the mineral soil surface.

Salorthidic Haploborolls

HEGB. Other Haploborolls that have, in part but not all of each pedon, a lithic contact within 50 cm of the mineral soil surface.

Ruptic-Lithic Haploborolls

HEGC. Other Haploborolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haploborolls

HEGD. Other Haploborolls which have *both*:

1. *Either* a chroma of 1 or less (crushed and smoothed sample) in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick, *or* a moisture control section that is not dry in all its parts throughout the year in 6 or more out or of 10 years; *and*

2. *One or both* of the following:

    a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

    b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Udertic Haploborolls

HEGE. Other Haploborolls which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has

that is moist in some or all of its parts throughout the year in 6 or more out of 10 years.

Cumulic Udic Haploborolls

HEGI. Other Haploborolls which have:

1. A mollic epipedon 40 cm or more thick, of which less than 50 percent has a sandy particle size, and no paralithic contact or sandy contrasting layer between 40 and 50 cm from the mineral soil surface; *and*

2. An irregular decrease in organic-carbon content from a depth of 25 cm below the mineral soil surface to a depth of 125 cm, or to a lithic or paralithic contact if shallower; *and*

3. A slope of less than 25 percent and a concave shape.

Cumulic Haploborolls

HEGJ. Other Haploborolls that have *both*:

1. A mollic epipedon 40 cm or more thick, of which less than 50 percent has a sandy particle size, and no paralithic contact or sandy contrasting layer between 40 and 50 cm from the mineral soil surface; *and*

2. *Either* a chroma of 1 or less (crushed and smoothed sample) in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick, *or* a moisture control section that is moist in some or all of its parts throughout the year in 6 or more out of 10 years.

Pachic Udic Haploborolls

HEGK. Other Haploborolls that have a mollic epipedon 40 cm or more thick, of which less than 50 percent has a sandy particle size, and no paralithic contact or sandy contrasting layer between 40 and 50 cm from the mineral soil surface.

Pachic Haploborolls

HEGL. Other Haploborolls that have:

1. *Either* 0.3 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a lithic or paralithic contact if shallower; *and*

2. In one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

3. A slope of less than 25 percent.

Fluvaquentic Haploborolls

HEGM. Other Haploborolls that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Haploborolls

HEGN. Other Haploborolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Haploborolls

HEGO. Other Haploborolls which have:

1. A color value, dry, of 5 or more either in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick; *and*

2. If not irrigated, a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is 5°C or higher; *and*

3. *Either* 0.3 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a lithic or paralithic contact if shallower; *and*

4. A slope of less than 25 percent.

Torrifluventic Haploborolls

HEGP. Other Haploborolls which:

1. Have a color value, dry, of 5 or more either in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick; *and*

2. If not irrigated, have a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

3. Do not have a cambic horizon and do not, in the lower part of the mollic epipedon, meet the requirements for a cambic horizon except color.

Torriorthentic Haploborolls

HEGQ. Other Haploborolls which have *both*:

1. A color value, dry, of 5 or more either in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick; *and*

2. A moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C.

Aridic Haploborolls

2. A mean summer soil temperature either at a depth of 50 cm below the soil surface or at a lithic or paralithic contact, whichever is shallower, of less than 15°C if there is no O horizon, or of less than 8°C if there is an O horizon.

Abruptic Cryic Paleborolls

HEAC. Other Paleborolls which have an argillic horizon that has a clay increase with depth of 20 percent or more (absolute, in the fine-earth fraction) within its upper 7.5 cm.

Abruptic Paleborolls

HEAD. Other Paleborolls which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Paleborolls

HEAE. Other Paleborolls that have a mean summer soil temperature either at a depth of 50 cm below the soil surface or at a lithic or paralithic contact, whichever is shallower, of less than 15°C if there is no O horizon, or of less than 8°C if there is an O horizon.

Cryic Paleborolls

HEAF. Other Paleborolls that have a mollic epipedon 50 cm or more thick.

Pachic Paleborolls

HEAG. Other Paleborolls that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Paleborolls

HEAH. Other Paleborolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Paleborolls

HEAI. Other Paleborolls.

Typic Paleborolls

Vermiborolls

<u>Key to subgroups</u>

HEEA. Vermiborolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Vermiborolls

HEEB. Other Vermiborolls which have *both*:

1. A color value, dry, of 5 either in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick; *and*

2. A moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C.

Aridic Vermiborolls

HEEC. Other Vermiborolls that have both:

1. A mollic epipedon less than 75 cm thick; *and*

2. A chroma of 1 or less (crushed and smoothed sample) either in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick.

Hapludic Vermiborolls

HEED. Other Vermiborolls that have a chroma of 1 or less (crushed and smoothed sample) either in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick.

Udic Vermiborolls

HEEE. Other Vermiborolls that have a mollic epipedon less than 75 cm thick.

Haplic Vermiborolls

HEEF. Other Vermiborolls.

Typic Vermiborolls

RENDOLLS

<u>Key to subgroups</u>

HCAA. Rendolls that have *both*:

1. A cryic or pergelic soil temperature regime; *and*

2. A lithic contact within 50 cm of the mineral soil surface.

Cryic Lithic Rendolls

HCAB. Other Rendolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Rendolls

HCAC. Other Rendolls that have a cryic or pergelic soil temperature regime.

Cryic Rendolls

HCAD. Other Rendolls which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Rendolls

HCAE. Other Rendolls that have *both*:

1. A cambic horizon; *and*

2. A difference of less than 5°C between mean summer and mean winter soil temperatures at a depth of 50 cm below the soil surface.

Eutropeptic Rendolls

HCAF. Other Rendolls that have a cambic horizon.

Eutrochreptic Rendolls

HCAG. Other Rendolls that have a color value, dry, of 6 or more either in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick.

Entic Rendolls

HCAH. Other Rendolls.

Typic Rendolls

UDOLLS

Key to great groups

HGA. Udolls which have *either*:

1. A petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface; *or*

2. *Both*:

a. Within 150 cm of the mineral soil surface, neither a lithic or paralithic contact nor a clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content; *and*

b. An argillic horizon which has *either*:

(1) In its lowest subhorizon, a hue of 7.5YR or redder and a chroma of 5 or more in 50 percent or more of the matrix· *o*a C

(2) In one or more of its subhorizons, many coarse redox concentrations with a hue of 5YR or redder or a chroma of 6 or more, or both.

Paleudolls, p. 372

HGB. Other Udolls which:

1. Have a calcic horizon that has its upper boundary within 100 cm of the mineral soil surface; *and*

2. Do *not* have an argillic horizon above the calcic horizon; *and*

3. In all parts above the calcic or petrocalcic horizon, after the materials between the soil surface and a depth of 18 cm have been mixed, are either calcareous or have a texture of loamy fine sand or coarser.

Calciudolls, p. 368

HGC. Other Udolls that have an argillic horizon.

Argiudolls, p. 365

HGD. Other Udolls that have a mollic epipedon which:

1. Either below an Ap horizon or below a depth of 18 cm from the mineral soil surface, contains 50 percent or more (by volume) wormholes, worm casts, or filled animal burrows; *and*

2. Either rests on a lithic contact, or has a transition zone to the underlying horizon in which 25 percent or more of the soil volume consists of discrete wormholes, worm casts, or animal burrows filled with material from the mollic epipedon and from the underlying horizon.

Vermudolls, p. 373

HGE. Other Udolls.

Hapludolls, p. 368

Argiudolls

Key to subgroups

HGCA. Argiudolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Argiudolls

HGCB. Other Argiudolls which have *both*:

1. Aquic conditions for some time in most years (or artificial drainage), *either*:

a. Within 40 cm of the mineral soil surface, in horizons that also have redoximorphic features; *or*

b. Directly below the mollic epipedon, in one or more horizons with a total thickness of 15 cm or more that have *one or more* of the following:

(1) A color value, moist, of 4 or more and redox depletions with a chroma of 2 or less; *or*

(2) A hue of 10YR or redder and a chroma of 2 or less; *or*

(3) A hue of 2.5Y or yellower and a chroma of 3 or less; *and*

2. *One or both* of the following:

a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Aquertic Argiudolls

HGCC. Other Argiudolls which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Argiudolls

HGCD. Other Argiudolls which have an argillic horizon that either has a texture of loamy fine sand or coarser, or consists entirely of lamellae.

Psammentic Argiudolls

HGCE. Other Argiudolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Argiudolls

HGCF. Other Argiudolls that have, throughout one or more horizons with a total thickness of 18 cm or more

HGCL. Other Argiudolls.

Typic Argiudolls

Calciudolls

Key to subgroups

HGBA. Calciudolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Calciudolls

HGBB. Other Calciudolls which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Calciudolls

HGBC. Other Calciudolls that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Calciudolls

HGBD. Other Calciudolls.

Typic Calciudolls

Hapludolls

Key to subgroups

HGEA. Hapludolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Hapludolls

HGEB. Other Hapludolls which have *both*:

1. Aquic conditions for some time in most years (or artificial drainage), *either*:

   a. Within 40 cm of the mineral soil surface, in horizons that also have redoximorphic features; *or*

   b. Directly below the mollic epipedon, in one or more horizons with a total thickness of 15 cm or more that have *one or more* of the following:

within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Vitrandic Argiudolls

HGCG. Other Argiudolls which have aquic conditions for some time in most years (or artificial drainage), *either*:

1. Within 40 cm of the mineral soil surface, in horizons that also have redoximorphic features; *or*

2. Directly below the mollic epipedon, in one or more horizons with a total thickness of 15 cm or more that have *one or more* of the following:

a. A color value, moist, of 4 or more and redox depletions with a chroma of 2 or less; *or*

b. A hue of 10YR or redder and a chroma of 2 or less; *or*

c. A hue of 2.5Y or yellower and a chroma of 3 or less.

Aquic Argiudolls

HGCH. Other Argiudolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Argiudolls

HGCI. Other Argiudolls that have a mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand.

Pachic Argiudolls

JGCJ. Other Argiudolls that have a CEC of less than 24 cmol(+)/kg clay (by 1N NH_4OAc pH 7) in 50 percent or more *either* of the argillic horizon if less than 100 cm thick, *or* of its upper 100 cm.

Oxic Argiudolls

HGCK. Other Argiudolls that have a calcic horizon within 100 cm of the mineral soil surface.

Calcic Argiudolls

Vermudolls

Key to subgroups

HGDA. Vermudolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Vermudolls

HGDB. Other Vermudolls that have a cambic horizon.

Haplic Vermudolls

HGDC. Other Vermudolls that have a mollic epipedon less than 75 cm thick.

Entic Vermudolls

HGDD. Other Vermudolls.

Typic Vermudolls

USTOLLS

Key to great groups

HFA. Ustolls which have a duripan that has its upper boundary within 100 cm of the mineral soil surface.

Durustolls, p. 382

HFB. Other Ustolls that have a natric horizon.

Natrustolls, p. 389

HFC. Other Ustolls which have *either*:

1. A petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface, *and* either an argillic horizon or, after the materials between the soil surface and a depth of 18 cm have been mixed, one or more noncalcareous horizons above the petrocalcic horizon; *or*

2. An argillic horizon that has *one or both* of the following:

a. *No* clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content within 150 cm of the mineral soil surface (and there is no lithic or paralithic contact within that depth), *and either*:

(1) A hue of 7.5YR or redder and a chroma of 5 or more in the matrix; *or*

(2) Common coarse redox concentrations with a hue of 7.5YR or redder or a chroma of 6 or more, or both; *or*

b. A clayey particle size in its upper part, and at its upper boundary, a clay increase of either 20 percent or more (absolute) within a vertical distance of 7.5 cm, or of 15

MOL

percent or more (absolute) within a vertical distance of 2.5 cm, in the fine-earth fraction (and there is no lithic or paralithic contact within 50 cm of the mineral soil surface).

Paleustolls, p. 391

HFD. Other Ustolls which:

1. Have *either* a calcic or gypsic horizon that has its upper boundary within 100 cm of the soil surface, *or* a petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface; *and*

2. Do not have an argillic horizon above the calcic, gypsic, or petrocalcic horizon; *and*

3. In all parts above the calcic, gypsic, or petrocalcic horizon, after the materials between the soil surface and a depth of 18 cm have been mixed, are either calcareous or have a texture of loamy fine sand or coarser.

Calciustolls, p. 379

HFE. Other Ustolls that have an argillic horizon.

Argiustolls, p. 374

HFF. Other Ustolls that have a mollic epipedon which:

1. Either below an Ap horizon or below a depth of 18 cm from the mineral soil surface, contains 50 percent or more (by volume) wormholes, worm casts, or filled animal burrows; *and*

2. Either rests on a lithic contact, or has a transition zone to the underlying horizon in which 25 percent or more of the soil volume consists of discrete wormholes, worm casts, or animal burrows filled with material from the mollic epipedon and from the underlying horizon.

Vermustolls, p. 394

HFG. Other Ustolls.

Haplustolls, p. 382

Argiustolls

Key to subgroups

HFEA. Argiustolls which have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*

2. Above the argillic horizon, either an albic horizon, or a horizon that has color values too high for a mollic epipedon and a chroma too high for an albic horizon.

Alfic Lithic Argiustolls

HFEB. Other Argiustolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Argiustolls

temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Udertic Argiustolls

HFEE. Other Argiustolls which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Argiustolls

HFEF. Other Argiustolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Argiustolls

HFEG. Other Argiustolls which have *both*:

1. If neither irrigated nor fallowed to store moisture, *either*:

a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C; *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

(1) In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

(2) In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Vitritorrandic Argiustolls

HFEH. Other Argiustolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Vitrandic Argiustolls

M
O
L

HFEI. Other Argiustolls which have a mean annual soil temperature lower than 10°C, *and either*:

1. Above the argillic horizon, an albic horizon, *or* a horizon that has color values too high for a mollic epipedon and a chroma too high for an albic horizon; *or*

2. A glossic horizon, *or* interfingering of albic materials into the upper part of the argillic horizon, *or* skeletans of clean silt and sand covering 50 percent or more of the faces of peds in the upper 5 cm of the argillic horizon.

Boralfic Argiustolls

HFEJ. Other Argiustolls which have *either*:

1. Above the argillic horizon, an albic horizon, *or* a horizon that has color values too high for a

mollic epipedon and a chroma too high for an albic horizon; *or*

2. A glossic horizon, *or* interfingering of albic materials into the upper part of the argillic horizon, *or* skeletans of clean silt and sand covering 50 percent or more of the faces of peds in the upper 5 cm of the argillic horizon.

Ustalfic Argiustolls

HFEK. Other Argiustolls that have a mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand.

Pachic Argiustolls

HFEL. Other Argiustolls that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Argiustolls

HFEM. Other Argiustolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Argiustolls

HFEN. Other Argiustolls which have, if neither irrigated nor fallowed to store moisture, *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Aridic Argiustolls

HFEO. Other Argiustolls which have, if neither irrigated nor fallowed to store moisture, *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for four tenths or less of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative

years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Torrertic Calciustolls

HFDE. Other Calciustolls which have *both*:

1. *One or both* of the following:

a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower; *and*

2. If neither irrigated nor fallowed to store moisture, *either*:

a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for four tenths or less of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Udertic Calciustolls

HFDF. Other Calciustolls which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Calciustolls

HFDG. Other Calciustolls which have a petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Petrocalcic Calciustolls

HFDH. Other Calciustolls that have a mollic epipedon 40 cm or more thick with a texture finer than loamy fine sand.

Pachic Calciustolls

HFDI. Other Calciustolls that have, in one or more horizons within 75 cm of the mineral soil surface, redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Calciustolls

HFDJ. Other Calciustolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Calciustolls

HFDK. Other Calciustolls which have, if neither irrigated nor fallowed to store moisture, *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Aridic Calciustolls

HFDL. Other Calciustolls which have, if neither irrigated nor fallowed to store moisture, *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for four tenths or less of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Udic Calciustolls

HFDM. Other Calciustolls.

Typic Calciustolls

Durustolls

Key to subgroups

HFAA. Durustolls that have a natric horizon above the duripan.

Natric Durustolls

HFAB. Other Durustolls which:

1. Do not have an argillic horizon above the duripan; *and*

2. Have an aridic moisture regime that borders on an ustic regime.

Orthidic Durustolls

HFAC. Other Durustolls that have an aridic moisture regime that borders on an ustic regime.

Aridic Durustolls

HFAD. Other Durustolls that do not have an argillic horizon above the duripan.

Entic Durustolls

HFAE. Other Durustolls which have a duripan that is not indurated in any subhorizon.

Haplic Durustolls

HFAF. Other Durustolls.

Typic Durustolls

Haplustolls

Key to subgroups

HFGA. Haplustolls which have a salic horizon that has its upper boundary within 75 cm of the mineral soil surface.

Salorthidic Haplustolls

HFGB. Other Haplustolls that have, in part of each pedon, a lithic contact within 50 cm of the mineral soil surface.

Ruptic-Lithic Haplustolls

HFGC. Other Haplustolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haplustolls

HFGD. Other Haplustolls which have *both*:

1. *One or both* of the following:

a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either

a depth of 100 cm or a lithic or paralithic contact, whichever is shallower; *and*

2. If neither irrigated nor fallowed to store moisture, *either*:

a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Torrertic Haplustolls

HFGE. Other Haplustolls which have *both*:

1. *One or both* of the following:

a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower; *and*

2. If neither irrigated nor fallowed to store moisture, *either*:

a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for four tenths or less of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Udertic Haplustolls

HFGF. Other Haplustolls which have *one or both* of the following:

fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Haplustolls

HFGJ. Other Haplustolls which have *both*:

1. If neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C; *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

   a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

   b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

      (1) In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

      (2) In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Vitritorrandic Haplustolls

HFGK. Other Haplustolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. *Either* do not have a cambic horizon and do not, in the lower part of the mollic epipedon, meet the requirements for a cambic horizon except color, *or* have carbonates throughout either the cambic horizon or the lower part of the mollic epipedon.

Torriorthentic Haplustolls

HFGT. Other Haplustolls which have, if neither irrigated nor fallowed to store moisture, *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Aridic Haplustolls

HFGU. Other Haplustolls which have *both*:

1. *Either* 0.3 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a lithic or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.

Fluventic Haplustolls

HFGV. Other Haplustolls which have a brittle horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and contains either some opal coatings or 20 percent or more (by volume) durinodes.

Duric Haplustolls

HFGW. Other Haplustolls which:

1. Have, if neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for four tenths or less of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C; *and*

2. *Either* do not have a cambic horizon and do not, in the lower part of the mollic epipedon, meet the requirements for a cambic horizon except color, *or* have carbonates throughout either the cambic horizon or the lower part of the mollic epipedon.

Udorthentic Haplustolls

HFGX. Other Haplustolls which have, if neither irrigated nor fallowed to store moisture, *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for four tenths or less of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Udic Haplustolls

HFGY. Other Haplustolls that *either* do not have a cambic horizon and do not, in the lower part of the mollic epipedon, meet the requirements for a cambic horizon except color, *or* have carbonates throughout either the cambic horizon or the lower part of the mollic epipedon.

Entic Haplustolls

HFGZ. Other Haplustolls.

Typic Haplustolls

Natrustolls

Key to subgroups

HFBA. Natrustolls which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Natrustolls

HFBB. Other Natrustolls that have visible crystals of gypsum or of more soluble salts, or both, within 40 cm of the mineral soil surface.

Leptic Natrustolls

HFBC. Other Natrustolls that have, in one or more horizons between 50 and 100 cm from the mineral soil surface, aquic conditions for some time in most years (or artificial drainage) *and one* of the following:

1. Fifty percent or more chroma of 1 or less, and a hue of 2.5Y or yellower; *or*

2. Fifty percent or more chroma of 2 or less, and redox concentrations; *or*

3. Fifty percent or more chroma of 2 or less; *and also* a higher exchangeable sodium percentage (or sodium adsorption ratio) between the mineral soil surface and a depth of 25 cm than in the underlying horizon.

Aquic Natrustolls

HFBD. Other Natrustolls which have, if neither irrigated nor fallowed to store moisture, *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Aridic Natrustolls

HFBE. Other Natrustolls which have a brittle horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and contains either some opal coatings or 20 percent or more (by volume) durinodes.

Duric Natrustolls

HFBF. Other Natrustolls that have a glossic horizon, or interfingering of albic materials into a natric horizon.

Glossic Natrustolls

HFBG. Other Natrustolls.

Typic Natrustolls

which, in 6 or more out of 10 years, is dry in some part for four tenths or less of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Udertic Paleustolls

HFCC. Other Paleustolls which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Paleustolls

HFCD. Other Paleustolls that have a mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand.

Pachic Paleustolls

HFCE. Other Paleustolls that have a petrocalcic horizon within 150 cm of the mineral soil surface.

Petrocalcic Paleustolls

HFCF. Other Paleustolls that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Paleustolls

HFCG. Other Paleustolls which:

1. Are calcareous throughout after the soil has been mixed to a depth of 18 cm, and have a calcic horizon within the following depths if the particle-size control section is

a. Sandy: within 100 cm of the mineral soil surface; *or*

b. Loamy: within 60 cm of the mineral soil surface; *or*

c. Clayey: within 50 cm of the mineral soil surface; *and*

2. Have, if neither irrigated nor fallowed to store moisture, *either*:

a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Calciorthidic Paleustolls

HFCH. Other Paleustolls which have, if neither irrigated nor fallowed to store moisture, *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Aridic Paleustolls

HFCI. Other Paleustolls which have, if neither irrigated nor fallowed to store moisture, *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for four tenths or less of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Udic Paleustolls

HFCJ. Other Paleustolls which are calcareous throughout after the soil has been mixed to a depth of 18 cm, and have a calcic horizon within the following depths if the particle-size control section is

1. Sandy: within 100 cm of the mineral soil surface; *or*

2. Loamy: within 60 cm of the mineral soil surface; *or*

3. Clayey: within 50 cm of the mineral soil surface.

Calcic Paleustolls

HFCK. Other Paleustolls that are calcareous throughout after the soil has been mixed to a depth of 18 cm.

Entic Paleustolls

HFCL. Other Paleustolls.

Typic Paleustolls

Vermustolls

Key to subgroups

HFFA. Vermustolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Vermustolls

HFFB. Other Vermustolls that have a mollic epipedon 75 cm or more thick.

Pachic Vermustolls

HFFC. Other Vermustolls that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Vermustolls

HFFD. Other Vermustolls that have a cambic horizon.

Haplic Vermustolls

HFFE. Other Vermustolls that have a mollic epipedon less than 50 cm thick.

Entic Vermustolls

HFFF. Other Vermustolls.

Typic Vermustolls

XEROLLS

Key to great groups

HDA. Xerolls that have a duripan within 100 cm of the mineral soil surface.

Durixerolls, p. 401

HDB. Other Xerolls which have a natric horizon, but do not have a petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface.

Natrixerolls, p. 409

either the mineral soil surface or an Ap horizon, whichever is deeper, and the lithic contact.

Lithic Ultic Argixerolls

HDEB. Other Argixerolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Argixerolls

HDEC. Other Argixerolls which have *both*:

1. An aridic moisture regime; *and*

2. *One or both* of the following:

a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Torrertic Argixerolls

HDED. Other Argixerolls which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Argixerolls

HDEE. Other Argixerolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Argixerolls

HDEF. Other Argixerolls that have *both*:

1. An aridic moisture regime; *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

(1) In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

(2) In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Vitritorrandic Argixerolls

HDEG. Other Argixerolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and *either*:

a. In the 0.02-to-2.0-mm fraction, more than 30 percent volcanic glass; *or*

b. In the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass, and in the fine-earth fraction, aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more.

Vitrandic Argixerolls

HDEH. Other Argixerolls which have a mean annual soil temperature lower than 10°C, *and either*:

1. Above the argillic horizon, an albic horizon, *or* a horizon that has color values too high for a mollic epipedon and a chroma too high for an albic horizon; *or*

2. A glossic horizon, *or* interfingering of albic materials into the upper part of the argillic horizon, *or* skeletans of clean silt and sand covering 50 percent or more of the faces of peds in the upper 5 cm of the argillic horizon.

Boralfic Argixerolls

HDEI. Other Argixerolls that have *both*:

1. A calcic horizon or soft powdery lime, either within the following depths or above a lithic or paralithic contact if shallower, if the particle-size control section is

2. A horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

Durargidic Argixerolls

HDEP. Other Argixerolls that have a horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

Duric Argixerolls

HDEQ. Other Argixerolls that have *both*:

1. An aridic moisture regime; *and*

2. A calcic horizon or soft powdery lime, either within the following depths or above a lithic or paralithic contact if shallower, if the particle-size control section is

a. Sandy: within 150 cm of the mineral soil surface; *or*

b. Loamy: within 110 cm of the mineral soil surface; *or*

c. Clayey: within 90 cm of the mineral soil surface.

Aridic Calcic Argixerolls

HDER. Other Argixerolls that have an aridic moisture regime.

Aridic Argixerolls

HDES. Other Argixerolls that have a calcic horizon or soft powdery lime, either within the following depths or above a lithic or paralithic contact if shallower, if the particle-size control section is

1. Sandy: within 150 cm of the mineral soil surface; *or*

2. Loamy: within 110 cm of the mineral soil surface; *or*

3. Clayey: within 90 cm of the mineral soil surface.

Calcic Argixerolls

HDET. Other Argixerolls that have a base saturation (by sum of cations) of 75 percent or less in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 75 cm or a lithic or paralithic contact, whichever is shallower.

Ultic Argixerolls

HDEU. Other Argixerolls that have an albic horizon above the argillic horizon.

Albic Argixerolls

HDEV. Other Argixerolls.

Typic Argixerolls

Calcixerolls

Key to subgroups

HDDA. Calcixerolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Calcixerolls

HDDB. Other Calcixerolls which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Calcixerolls

HDDC. Other Calcixerolls that have a mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand.

Pachic Calcixerolls

HDDD. Other Calcixerolls that have, in one or more horizons within 75 cm of the mineral soil surface, redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Calcixerolls

HDDE. Other Calcixerolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Calcixerolls

HDDF. Other Calcixerolls that have an aridic moisture regime.

Aridic Calcixerolls

HDDG. Other Calcixerolls which have a mollic epipedon that contains, below any Ap horizon, 50 percent or more (by volume) wormholes, worm casts, or filled animal burrows.

Vermic Calcixerolls

HDDH. Other Calcixerolls.

Typic Calcixerolls

percentages (by ammonium oxalate) totaling 0.40 or more.

Vitrandic Durixerolls

HDAD. Other Durixerolls that have, in one or more horizons above the duripan, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Durixerolls

HDAE. Other Durixerolls which have *both*:

1. An aridic moisture regime; *and*

2. An argillic horizon that has a clay increase with depth *either* of 20 percent or more (absolute) within its upper 7.5 cm, *or* of 15 percent or more (absolute) within its upper 2.5 cm, in the fine-earth fraction.

Abruptic Aridic Durixerolls

HDAF. Other Durixerolls that:

1. Do not have an argillic horizon above the duripan; *and*

2. Have an aridic moisture regime.

Orthidic Durixerolls

HDAG. Other Durixerolls that have an aridic moisture regime.

Aridic Durixerolls

HDAH. Other Durixerolls which have an argillic horizon that has a clay increase with depth *either* of 20 percent or more (absolute) within its upper 7.5 cm, *or* of 15 percent or more (absolute) within its upper 2.5 cm, in the fine-earth fraction.

Abruptic Durixerolls

HDAI. Other Durixerolls which:

1. Have a duripan that is not indurated in any subhorizon; *and*

2. Do not have an argillic horizon above the duripan.

Entic Durixerolls

HDAJ. Other Durixerolls that do not have an argillic horizon above the duripan.

Haplic Durixerolls

HDAK. Other Durixerolls which have a duripan that is not indurated in any subhorizon.

Argic Durixerolls

HDAL. Other Durixerolls.

Typic Durixerolls

3. A slope of less than 25 percent.

Fluvaquentic Haploxerolls

HDFM. Other Haploxerolls that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. A horizon 15 cm or more thick within 100 cm of the mineral soil surface that either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

Aquic Duric Haploxerolls

HDFN. Other Haploxerolls that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. A base saturation (by sum of cations) of 75 percent or less in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 75 cm or a lithic or paralithic contact, whichever is shallower.

Aquultic Haploxerolls

HDFO. Other Haploxerolls that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Haploxerolls

HDFP. Other Haploxerolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Haploxerolls

HDFQ. Other Haploxerolls which have:

1. An aridic moisture regime; *and*

2. *Either* 0.3 percent or more organic carbon in all horizons within 125 cm of the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a lithic or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.

Torrifluventic Haploxerolls

HDFR. Other Haploxerolls which have *both*:

1. An aridic moisture regime; *and*

2. A horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

Aridic Duric Haploxerolls

HDFS. Other Haploxerolls that have *both*:

1. An aridic moisture regime; *and*

2. A calcic horizon or soft powdery lime, either within the following depths or above a lithic or paralithic contact if shallower, if the particle-size control section is

a. Sandy: within 150 cm of the mineral soil surface; *or*

b. Loamy: within 110 cm of the mineral soil surface; *or*

c. Clayey: within 90 cm of the mineral soil surface.

Calciorthidic Haploxerolls

HDFT. Other Haploxerolls that have *both*:

1. An aridic moisture regime; *and*

2. A sandy particle size in all horizons within 100 cm of the mineral soil surface.

Torripsammentic Haploxerolls

HDFU. Other Haploxerolls which:

1. Have an aridic moisture regime; *and*

2. *Either* do not have a cambic horizon and do not, in the lower part of the mollic epipedon, meet the requirements for a cambic horizon except color, *or* have carbonates throughout either the cambic horizon or the lower part of the mollic epipedon.

Torriorthentic Haploxerolls

HDFV. Other Haploxerolls that have an aridic moisture regime.

Aridic Haploxerolls

HDFW. Other Haploxerolls that have a horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

Duric Haploxerolls

HDFX. Other Haploxerolls which have *both*:

1. *Either* 0.3 percent or more organic carbon in all horizons within 125 cm of the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a lithic or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.

Fluventic Haploxerolls

HDFY. Other Haploxerolls that have a mollic epipedon which has granular structure and which contains, below any Ap horizon, 50 percent or more (by volume) wormholes, worm casts, or filled animal burrows.

Vermic Haploxerolls

HDFZ. Other Haploxerolls that have a calcic horizon or soft powdery lime, either within the following depths or above a lithic or paralithic contact if shallower, if the particle-size control section is

1. Sandy: within 150 cm of the mineral soil surface; *or*

2. Loamy: within 110 cm of the mineral soil surface; *or*

3. Clayey: within 90 cm of the mineral soil surface.

Calcic Haploxerolls

HDFZa. Other Haploxerolls which:

1. Do not have a cambic horizon and do not, in the lower part of the mollic epipedon, meet the requirements for a cambic horizon except color; *and*

2. Have a base saturation (by sum of cations) of 75 percent or less in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 75 cm or a lithic or paralithic contact, whichever is shallower.

Entic Ultic Haploxerolls

HDFZb. Other Haploxerolls that have a base saturation (by sum of cations) of 75 percent or less in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 75 cm or a lithic or paralithic contact, whichever is shallower.

Ultic Haploxerolls

HDFZc. Other Haploxerolls that *either* do not have a cambic horizon and do not, in the lower part of the mollic epipedon, meet the requirements for a cambic horizon except color, *or* have carbonates throughout either the cambic horizon or the lower part of the mollic epipedon.

Entic Haploxerolls

HDFZd. Other Haploxerolls.

Typic Haploxerolls

(absolute) within a vertical distance of 2.5 cm, in the fine-earth fraction.

Haplic Palexerolls

HDCJ. Other Palexerolls.

Typic Palexerolls

Chapter 13

Oxisols[1]

KEY TO SUBORDERS

DA. Oxisols that have aquic conditions for some time in most years (or artificial drainage) in one or more horizons within 50 cm of the mineral soil surface, *and one or more* of the following:

1. A histic epipedon; *or*

2. An epipedon with a color value, moist, of 3 or less, and directly below it, a horizon with a chroma of 2 or less; *or*

3. Distinct or prominent redox concentrations within 50 cm of the mineral soil surface, an epipedon, and directly below it, a horizon with *one or both* of the following:

    a. Fifty percent or more hue of 2.5Y or yellower; *or*

    b. A chroma of 3 or less; *or*

4. Within 50 cm of the mineral soil surface, enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquox, p. 414

DB. Other Oxisols that have an aridic moisture regime.
Torrox, p. 423

DC. Other Oxisols that have an ustic moisture regime.
Ustox, p. 432

DD. Other Oxisols that have a perudic moisture regime.
Perox, p. 415

DE. Other Oxisols.
Udox, p. 424

[1] This chapter on Oxisols was rewritten in 1987 following the recommendations of the International Committee on the Classification of Oxisols (ICOMOX), chaired by Hari Eswaran from 1978 to 1981 and then by S.W. Buol until completion of the task in 1987.

AQUOX

Key to great groups

DAA. Aquox that have, in one or more subhorizons of the oxic horizon within 150 cm of the mineral soil surface, an ECEC of less than 1.50 cmol(+)/kg clay and a pH value (in 1N KCl) of 5.0 or more.

Acraquox, p. 414

DAB. Other Aquox that have plinthite forming a continuous phase within 125 cm of the mineral soil surface.

Plinthaquox, p. 415

DAC. Other Aquox that have a base saturation (by NH_4OAc) of 35 percent or more in all horizons within 125 cm of the mineral soil surface.

Eutraquox, p. 414

DAD. Other Aquox.

Haplaquox, p. 415

Acraquox

Key to subgroups

DAAA. Acraquox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Acraquox

DAAB. Other Acraquox which have, directly below an epipedon, a horizon 10 cm or more thick that has 50 percent or more chroma of 3 or more.

Aeric Acraquox

DAAC. Other Acraquox.

Typic Acraquox

Eutraquox

Key to subgroups

DACA. Eutraquox that have a histic epipedon.

Histic Eutraquox

DACB. Other Eutraquox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Eutraquox

DACC. Other Eutraquox which have, directly below an epipedon, a horizon 10 cm or more thick that has 50 percent or more chroma of 3 or more.

Aeric Eutraquox

DDBG. Other Acroperox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
Aquic Acroperox

DDBH. Other Acroperox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.
Humic Rhodic Acroperox

DDBI. Other Acroperox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.
Humic Xanthic Acroperox

DDBJ. Other Acroperox that have 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm.
Humic Acroperox

DDBK. Other Acroperox that have 50 percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.
Rhodic Acroperox

DDBL. Other Acroperox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.
Xanthic Acroperox

DDBM. Other Acroperox.
Typic Acroperox

Eutroperox

Key to subgroups

DDCA. Eutroperox that have, within 125 cm of the mineral soil surface, *both*:

1. A petroferric contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
Aquic Petroferric Eutroperox

DDCB. Other Eutroperox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Eutroperox

DDCC. Other Eutroperox that have, within 125 cm of the mineral soil surface, *both*:

1. A lithic contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Lithic Eutroperox

DDCD. Other Eutroperox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Eutroperox

DDCE. Other Eutroperox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. Five percent or more (by volume) plinthite; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Plinthaquic Eutroperox

DDCF. Other Eutroperox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Eutroperox

DDCG. Other Eutroperox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Eutroperox

DDCH. Other Eutroperox that have *both*:

1. A clay content of 40 percent or more in the fine-earth fraction between the soil surface and a depth of 18 cm, after mixing; *and*

2. A kandic horizon that has its upper boundary within 150 cm of the mineral soil surface.

Kandiudalfic Eutroperox

DDCI. Other Eutroperox which have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. An oxic horizon that has its lower boundary within 125 cm of the mineral soil surface.

Umbreptic Eutroperox

DDCJ. Other Eutroperox which have an oxic horizon that has its lower boundary within 125 cm of the mineral soil surface.

Inceptic Eutroperox

DDCK. Other Eutroperox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

Humic Rhodic Eutroperox

DDCL. Other Eutroperox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Humic Xanthic Eutroperox

DDCM. Other Eutroperox that have 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Eutroperox

DDCN. Other Eutroperox that have 50 percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

Rhodic Eutroperox

DDCO. Other Eutroperox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Xanthic Eutroperox

DDCP. Other Eutroperox.

Typic Eutroperox

Haploperox

Key to subgroups

DDEA. Haploperox that have, within 125 cm of the mineral soil surface, *both*:

1. A petroferric contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Petroferric Haploperox

DDEB. Other Haploperox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Haploperox

DDEC. Other Haploperox that have, within 125 cm of the mineral soil surface, *both*:

1. A lithic contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Lithic Haploperox

DDED. Other Haploperox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Haploperox

DDEE. Other Haploperox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. Five percent or more (by volume) plinthite; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Plinthaquic Haploperox

DDEF. Other Haploperox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Haploperox

DDEG. Other Haploperox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Haploperox

DDEH. Other Haploperox that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Haploperox

DDEI. Other Haploperox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

Humic Rhodic Haploperox

DDEJ. Other Haploperox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

1. Five percent or more (by volume) plinthite; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Plinthaquic Kandiperox

DDDF. Other Kandiperox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Kandiperox

DDDG. Other Kandiperox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Kandiperox

DDDH. Other Kandiperox that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Kandiperox

DDDI. Other Kandiperox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

Humic Rhodic Kandiperox

DDDJ. Other Kandiperox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Humic Xanthic Kandiperox

DDDK. Other Kandiperox that have 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Kandiperox

DDDL. Other Kandiperox that have 50 percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

Rhodic Kandiperox

DDDM. Other Kandiperox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or

Eutrotorrox

Key to subgroups

DBBA. Eutrotorrox that have a petroferric contact within 125 cm of the mineral soil surface.
Petroferric Eutrotorrox

DBBB. Other Eutrotorrox that have a lithic contact within 125 cm of the mineral soil surface.
Lithic Eutrotorrox

DBBC. Other Eutrotorrox.
Typic Eutrotorrox

Haplotorrox

Key to subgroups

DBCA. Haplotorrox that have a petroferric contact within 125 cm of the mineral soil surface.
Petroferric Haplotorrox

DBCB. Other Haplotorrox that have a lithic contact within 125 cm of the mineral soil surface.
Lithic Haplotorrox

DBCC. Other Haplotorrox.
Typic Haplotorrox

UDOX

Key to great groups

DEA. Udox that have a sombric horizon within 150 cm of the mineral soil surface.
Sombriudox, p. 432

DEB. Other Udox that have, in one or more subhorizons of the oxic or kandic horizon within 150 cm of the mineral soil surface, an ECEC of less than 1.50 cmol(+)/kg clay and a pH value (in 1N KCl) of 5.0 or more.
Acrudox, p. 425

DEC. Other Udox that have a base saturation (by NH_4OAc) of 35 percent or more in all horizons within 125 cm of the mineral soil surface.
Eutrudox, p. 426

DED. Other Udox that have *both*:

1. A clay content of 40 percent or more in the fine-earth fraction between the soil surface and a depth of 18 cm, after mixing; *and*

2. A kandic horizon that has its upper boundary within 150 cm of the mineral soil surface.
Kandiudox, p. 430

redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Acrudox

DEBI. Other Acrudox that have a base saturation (by NH_4OAc) of 35 percent or more in all horizons within 125 cm of the mineral soil surface.

Eutric Acrudox

DEBJ. Other Acrudox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

Humic Rhodic Acrudox

DEBK. Other Acrudox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Humic Xanthic Acrudox

DEBL. Other Acrudox that have 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Acrudox

DEBM. Other Acrudox that have 50 percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

Rhodic Acrudox

DEBN. Other Acrudox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Xanthic Acrudox

DEBO. Other Acrudox.

Typic Acrudox

Eutrudox

<u>Key to subgroups</u>

DECA. Eutrudox that have, within 125 cm of the mineral soil surface, *both*:

1. A petroferric contact; *and*

2. An oxic horizon that has its lower boundary within 125 cm of the mineral soil surface.

Umbreptic Eutrudox

DECJ. Other Eutrudox which have an oxic horizon that has its lower boundary within 125 cm of the mineral soil surface.

Inceptic Eutrudox

DECK. Other Eutrudox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

Humic Rhodic Eutrudox

DECL. Other Eutrudox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Humic Xanthic Eutrudox

DECM. Other Eutrudox that have 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Eutrudox

DECN. Other Eutrudox that have 50 percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

Rhodic Eutrudox

DECO. Other Eutrudox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Xanthic Eutrudox

DECP. Other Eutrudox.

Typic Eutrudox

Hapludox

Key to subgroups

DEEA. Hapludox that have, within 125 cm of the mineral soil surface, *both*:

1. A petroferric contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Petroferric Hapludox

DEEB. Other Hapludox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Hapludox

DEEC. Other Hapludox that have, within 125 cm of the mineral soil surface, *both*:

1. A lithic contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Lithic Hapludox

DEED. Other Hapludox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Hapludox

DEEE. Other Hapludox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. Five percent or more (by volume) plinthite; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Plinthaquic Hapludox

DEEF. Other Hapludox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Hapludox

DEEG. Other Hapludox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Hapludox

DEEH. Other Hapludox which have an oxic horizon that has its lower boundary within 125 cm of the mineral soil surface.

Inceptic Hapludox

DEEI. Other Hapludox that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Hapludox

DEEJ. Other Hapludox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

Humic Rhodic Hapludox

DEEK. Other Hapludox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Humic Xanthic Hapludox

DEEL. Other Hapludox that have 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Hapludox

DEEM. Other Hapludox that have 50 percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

Rhodic Hapludox

DEEN. Other Hapludox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Xanthic Hapludox

DEEO. Other Hapludox.

Typic Hapludox

Kandiudox

Key to subgroups

DEDA. Kandiudox that have, within 125 cm of the mineral soil surface, *both*:

1. A petroferric contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Petroferric Kandiudox

DEDB. Other Kandiudox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Kandiudox

DEDC. Other Kandiudox that have, within 125 cm of the mineral soil surface, *both*:

1. A lithic contact; *and*

DEDK. Other Kandiudox that have 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Kandiudox

DEDL. Other Kandiudox that have 50 percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

Rhodic Kandiudox

DEDM. Other Kandiudox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Xanthic Kandiudox

DEDN. Other Kandiudox.

Typic Kandiudox

Sombriudox

Key to subgroups

DEAA. Sombriudox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Sombriudox

DEAB. Other Sombriudox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Sombriudox

DEAC. Other Sombriudox that have 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Sombriudox

DEAD. Other Sombriudox.

Typic Sombriudox

USTOX

Key to great groups

DCA. Ustox that have a sombric horizon within 150 cm of the mineral soil surface.

Sombriustox, p. 440

DCB. Other Ustox that have, in one or more subhorizons of the oxic or kandic horizon within 150 cm of the mineral soil surface, an ECEC of less than 1.50 cmol(+)/kg clay and a pH value (in 1N KCl) of 5.0 or more.

Acrustox, p. 433

DCC. Other Ustox that have a base saturation (by NH_4OAc) of 35 percent or more in all horizons within 125 cm of the mineral soil surface.

Eutrustox, p. 435

DCD. Other Ustox that have *both*:

1. A clay content of 40 percent or more in the fine-earth fraction between the soil surface and a depth of 18 cm, after mixing; *and*

2. A kandic horizon that has its upper boundary within 150 cm of the mineral soil surface.
Kandiustox, p. 438

DCE. Other Ustox.
Haplustox, p. 436

Acrustox

Key to subgroups

DCBA. Acrustox that have, within 125 cm of the mineral soil surface, *both*:

1. A petroferric contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
Aquic Petroferric Acrustox

DCBB. Other Acrustox that have a petroferric contact within 125 cm of the mineral soil surface.
Petroferric Acrustox

DCBC. Other Acrustox that have, within 125 cm of the mineral soil surface, *both*:

1. A lithic contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
Aquic Lithic Acrustox

DCBD. Other Acrustox that have a lithic contact within 125 cm of the mineral soil surface.
Lithic Acrustox

DCBE. Other Acrustox that have, within 125 cm of the mineral soil surface, *both*:

1. A delta pH (KCl pH minus 1:1 water pH) with a 0 or net positive charge in a layer 18 cm or more thick; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
Anionic Aquic Acrustox

DCBF. Other Acrustox that have a delta pH (KCl pH minus 1:1 water pH) with a 0 or net positive charge in a layer 18 cm or more thick within 125 cm of the mineral soil surface.

Anionic Acrustox

DCBG. Other Acrustox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Acrustox

DCBH. Other Acrustox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Acrustox

DCBI. Other Acrustox that have a base saturation (by NH_4OAc) of 35 percent or more in all horizons within 125 cm of the mineral soil surface.

Eutric Acrustox

DCBJ. Other Acrustox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

Humic Rhodic Acrustox

DCBK. Other Acrustox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Humic Xanthic Acrustox

DCBL. Other Acrustox that have 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Acrustox

DCBM. Other Acrustox that have 50 percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

Rhodic Acrustox

DCBN. Other Acrustox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Xanthic Acrustox

DCBO. Other Acrustox.

Typic Acrustox

Eutrustox

Key to subgroups

DCCA. Eutrustox that have, within 125 cm of the mineral soil surface, *both*:

1. A petroferric contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Petroferric Eutrustox

DCCB. Other Eutrustox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Eutrustox

DCCC. Other Eutrustox that have, within 125 cm of the mineral soil surface, *both*:

1. A lithic contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Lithic Eutrustox

DCCD. Other Eutrustox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Eutrustox

DCCE. Other Eutrustox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. Five percent or more (by volume) plinthite; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Plinthaquic Eutrustox

DCCF. Other Eutrustox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Eutrustox

DCCG. Other Eutrustox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Eutrustox

DCCH. Other Eutrustox that have *both*:

1. A clay content of 40 percent or more in the fine-earth fraction between the soil surface and a depth of 18 cm, after mixing; *and*

surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Haplustox

DCEJ. Other Haplustox which have an oxic horizon that has its lower boundary within 125 cm of the mineral soil surface.

Inceptic Haplustox

DCEK. Other Haplustox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

Humic Rhodic Haplustox

DCEL. Other Haplustox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Humic Xanthic Haplustox

DCEM. Other Haplustox that have 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Haplustox

DCEN. Other Haplustox that have 50 percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

Rhodic Haplustox

DCEO. Other Haplustox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Xanthic Haplustox

DCEP. Other Haplustox.

Typic Haplustox

Kandiustox

Key to subgroups

DCDA. Kandiustox that have, within 125 cm of the mineral soil surface, *both*:

1. A petroferric contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Petroferric Kandiustox

DCDB. Other Kandiustox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Kandiustox

DCDC. Other Kandiustox that have, within 125 cm of the mineral soil surface, *both*:

1. A lithic contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Lithic Kandiustox

DCDD. Other Kandiustox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Kandiustox

DCDE. Other Kandiustox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. Five percent or more (by volume) plinthite; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Plinthaquic Kandiustox

DCDF. Other Kandiustox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Kandiustox

DCDG. Other Kandiustox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Kandiustox

DCDH. Other Kandiustox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

Humic Rhodic Kandiustox

DCDI. Other Kandiustox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Humic Xanthic Kandiustox

DCDJ. Other Kandiustox that have 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Kandiustox

DCDK. Other Kandiustox that have 50 percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

Rhodic Kandiustox

DCDL. Other Kandiustox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Xanthic Kandiustox

DCDM. Other Kandiustox.

Typic Kandiustox

Sombriustox

Key to subgroups

DCAA. Sombriustox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Sombriustox

DCAB. Other Sombriustox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Sombriustox

DCAC. Other Sombriustox that have 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Sombriustox

DCADtlOth Soppbrimtt h m el b

Chapter 14

Spodosols[1]

KEY TO SUBORDERS

BA. Spodosols that have aquic conditions for some time in most years (or artificial drainage) in one or more horizons within 50 cm of the mineral soil surface, *and one or both* of the following:

1. A histic epipedon; *or*

2. Within 50 cm of the mineral soil surface, redoximorphic features in an albic or a spodic horizon.

Aquods, p. 441

BB. Other Spodosols that have a cryic or pergelic soil temperature regime.

Cryods, p. 445

BC. Other Spodosols that have 6 percent or more organic carbon in a layer 10 cm or more thick within the spodic horizon.

Humods, p. 448

BD. Other Spodosols.

Orthods, p. 450

AQUODS

Key to great groups

BAA. Aquods that have a cryic or pergelic soil temperature regime.

Cryaquods, p. 443

BAB. Other Aquods that have less than 0.10 percent iron (by ammonium oxalate) in 75 percent or more of the spodic horizon.

Alaquods, p. 442

BAC. Other Aquods that have a fragipan.

Fragiaquods, p. 445

BAD. Other Aquods that have a placic horizon within 100 cm of the mineral soil surface in 50 percent or more of each pedon.

Placaquods, p. 445

---

[1] This chapter on Spodosols was rewritten in 1992 following the recommendations of the International Committee on the Classification of Spodosols (ICOMOD), chaired initially by F. Ted Miller, then by Robert V. Rourke (since 1986).

BAFE. Other Epiaquods that have an argillic or a kandic horizon within 200 cm of the mineral soil surface.

Ultic Epiaquods

BAFF. Other Epiaquods that have an umbric epipedon.

Umbric Epiaquods

BAFG. Other Epiaquods.

Typic Epiaquods

Fragiaquods

Key to subgroups

BACA. Fragiaquods that have a histic epipedon.

Histic Fragiaquods

BACB. Other Fragiaquods which have a surface horizon 30 cm or more thick that meets all the requirements for a plaggen epipedon except thickness.

Plaggeptic Fragiaquods

BACC. Other Fragiaquods which have, within 200 cm of the mineral soil surface, an argillic or a kandic horizon.

Argic Fragiaquods

BACD. Other Fragiaquods.

Typic Fragiaquods

Placaquods

Key to subgroups

BADA. Placaquods which have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Andic Placaquods

BADB. Other Placaquods.

Typic Placaquods

CRYODS

Key to great groups

BBA. Cryods that have a placic horizon within 100 cm of the mineral soil surface in 50 percent or more of each pedon.

Placocryods, p. 448

BBB. Other Cryods which have, in 90 percent or more of each pedon, a cemented soil layer that does not slake in water after air-drying and has its upper boundary within 100 cm of the mineral soil surface.

Duricryods, p. 446

BBC. Other Cryods that have 6 percent or more organic carbon throughout a layer 10 cm or more thick within the spodic horizon.

Humicryods, p. 447

BBD. Other Cryods.

Haplocryods, p. 446

Duricryods

Key to subgroups

BBBA. Duricryods which have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redoximorphic features, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. Andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Aquandic Duricryods

BBBB. Other Duricryods which have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Andic Duricryods

BBBC. Other Duricryods that have, in one or more horizons within 75 cm of the mineral soil surface, redoximorphic features, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Duricryods

BBBD. Other Duricryods that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Duricryods

BBBE. Other Duricryods that have 6 percent or more organic carbon throughout a layer 10 cm or more thick within the spodic horizon.

Humic Duricryods

BBBF. Other Duricryods.

Typic Duricryods

Haplocryods

Key to subgroups

BBDA. Haplocryods that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haplocryods

BBDB. Other Haplocryods that have a mean annual soil temperature of 0°C or less.

Pergelic Haplocryods

BBDC. Other Haplocryods which have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redoximorphic features, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. Andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Aquandic Haplocryods

BBDD. Other Haplocryods which have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Andic Haplocryods

BBDE. Other Haplocryods that have, in one or more horizons within 75 cm of the mineral soil surface, redoximorphic features, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Haplocryods

BBDF. Other Haplocryods that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Haplocryods

BBDG. Other Haplocryods that have 1.1 percent or less organic carbon in the upper 10 cm of the spodic horizon.

Entic Haplocryods

BBDH. Other Haplocryods.

Typic Haplocryods

Humicryods

Key to subgroups

BBCA. Humicryods that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Humicryods

SPO

BBCB. Other Humicryods that have a mean annual soil temperature of 0°C or less.

Pergelic Humicryods

BBCC. Other Humicryods which have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redoximorphic features, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. Andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Aquandic Humicryods

BBCD. Other Humicryods which have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Andic Humicryods

BBCE. Other Humicryods that have, in one or more horizons within 75 cm of the mineral soil surface, redoximorphic features, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Humicryods

BBCF. Other Humicryods that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Humicryods

BBCG. Other Humicryods.

Typic Humicryods

Placocryods

Key to subgroups

BBAA. Placocryods which have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Andic Placocryods

BBAB. Other Placocryods that have 6 percent or more organic carbon in a layer 10 cm or more thick within the spodic horizon.

Humic Placocryods

BBAC. Other Placocryods.

Typic Placocryods

HUMODS

Key to great groups

BCA. Humods that have a placic horizon within 100 cm of the mineral soil surface in 50 percent or more of each pedon.

Placohumods, p. 449

BCB. Other Humods which have, in 90 percent or more of each pedon, a cemented soil layer that does not slake in water after air-drying and has its upper boundary within 100 cm of the mineral soil surface.

Durihumods, p. 449

BCC. Other Humods that have a fragipan.

Fragihumods, p. 449

BCD. Other Humods.

Haplohumods, p. 449

Durihumods

Key to subgroups

BCBA. Durihumods which have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Andic Durihumods

BCBB. Other Durihumods.

Typic Durihumods

Fragihumods

Key to subgroups

BCCA. All Fragihumods (provisionally).

Typic Fragihumods

Haplohumods

Key to subgroups

BCDA. Haplohumods that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haplohumods

BCDB. Other Haplohumods which have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Andic Haplohumods

BCDC. Other Haplohumods which have a surface horizon 30 cm or more thick that meets all the requirements for a plaggen epipedon except thickness.

Plaggeptic Haplohumods

BCDD. Other Haplohumods.

Typic Haplohumods

Placohumods

Key to subgroups

BCAA. Placohumods which have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Andic Placohumods

BCAB. Other Placohumods.

Typic Placohumods

ORTHODS

Key to great groups

BDA. Orthods that have, in 50 percent or more of each pedon, a placic horizon within 100 cm of the mineral soil surface.

Placorthods, p. 454

BDB. Other Orthods which have, in 90 percent or more of each pedon, a cemented soil layer that does not slake in water after air-drying and has its upper boundary within 100 cm of the mineral soil surface.

Durorthods, p. 451

BDC. Other Orthods that have a fragipan.

Fragiorthods, p. 451

BDD. Other Orthods that have less than 0.10 percent iron (by ammonium oxalate) in 75 percent or more of the spodic horizon.

Alorthods, p. 450

BDE. Other Orthods.

Haplorthods, p. 452

Alorthods

Key to subgroups

BDDA. Alorthods that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Alorthods

BDDB. Other Alorthods that have *both*:

1. A sandy particle size throughout a layer extending from the mineral soil surface to the top of the spodic horizon at a depth of 75 to 125 cm; *and*

2. An argillic or a kandic horizon below the spodic horizon.

Arenic Ultic Alorthods

BDDC. Other Alorthods that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of the spodic horizon at a depth of 75 to 125 cm.

Arenic Alorthods

BDDD. Other Alorthods that have *both*:

1. A sandy particle size throughout a layer extending from the mineral soil surface to the top of the spodic horizon at a depth of 125 cm or more; *and*

2. In 10 percent or more of each pedon, less than 3 percent organic carbon in the upper 2 cm of the spodic horizon.

Grossarenic Entic Alorthods

BDDE. Other Alorthods that have, in 10 percent or more of each pedon, less than 3 percent organic carbon in the upper 2 cm of the spodic horizon.

Entic Alorthods

BDDF. Other Alorthods that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of the spodic horizon at a depth of 125 cm or more.

Grossarenic Alorthods

BDDG. Other Alorthods which have a surface horizon 30 cm or more thick that meets all the requirements for a plaggen epipedon except thickness.

Plaggeptic Alorthods

BDDH. Other Alorthods which have, within 200 cm of the mineral soil surface, an argillic or a kandic horizon that has a base saturation of 35 percent or more (by sum of cations) in some part.

Alfic Alorthods

BDDI. Other Alorthods that have an argillic or a kandic horizon within 200 cm of the mineral soil surface.

Ultic Alorthods

BDDJ. Other Alorthods.

Typic Alorthods

Durorthods

Key to subgroups

BDBA. Durorthods which have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Andic Durorthods

BDBB. Other Durorthods.

Typic Durorthods

Fragiorthods

Key to subgroups

BDCA. Fragiorthods that have, in one or more horizons within 75 cm of the mineral soil surface, redoximorphic features, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Fragiorthods

BDCB. Other Fragiorthods that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Fragiorthods

BDCC. Other Fragiorthods which have a surface horizon 30 cm or more thick that meets all the requirements for a plaggen epipedon except thickness.

Plaggeptic Fragiorthods

BDCD. Other Fragiorthods which have, within 200 cm of the mineral soil surface, an argillic or a kandic horizon that has a base saturation of 35 percent or more (by sum of cations) in some part.

Alfic Fragiorthods

BDCE. Other Fragiorthods that have an argillic or a kandic horizon within 200 cm of the mineral soil surface.

Ultic Fragiorthods

BDCF. Other Fragiorthods which have a spodic horizon that does not have *any* of the following:

1. A texture of very fine sand or finer, a thickness of more than 10 cm, and a weighted average of 1.2 percent or more organic carbon in the upper 10 cm; *nor*

2. A coarse-loamy or loamy-skeletal particle size, and a color value, moist, and chroma of 3 or less (crushed and smoothed sample) in the upper 7.5 cm; *nor*

3. A sandy-skeletal or sandy particle size, and a color value, moist, and chroma of 3 or less (crushed and smoothed sample) in the upper 2.5 cm.

Entic Fragiorthods

BDCG. Other Fragiorthods.

Typic Fragiorthods

Haplorthods

Key to subgroups

BDEA. Haplorthods which have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*

2. A spodic horizon that does not have *any* of the following:

   a. A texture of very fine sand or finer, a thickness of more than 10 cm, and a

Chapter 15

Ultisols

KEY TO SUBORDERS

GA. Ultisols that have aquic conditions for some time in most years (or artificial drainage) in one or more horizons within 50 cm of the mineral soil surface, *and one or both* of the following:

1. Redoximorphic features in all layers between either the lower boundary of an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 40 cm; *and one* of the following within the upper 12.5 cm of the argillic or kandic horizon:

   a. Redox concentrations, and 50 percent or more redox depletions with a chroma of 2 or less either on faces of peds or in the matrix; *or*

   b. Fifty percent or more redox depletions with a chroma of 1 or less either on faces of peds or in the matrix; *or*

   c. Distinct or prominent redox concentrations and 50 percent or more hue of 2.5Y or 5Y in the matrix, *and also* a thermic, isothermic, or warmer soil temperature regime; *or*

2. Within 50 cm of the mineral soil surface, enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquults, p. 456

GB. Other Ultisols that have *one or both* of the following:

1. 0.9 percent or more organic carbon in the upper 15 cm of the argillic or kandic horizon; *or*

2. 12 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humults, p. 463

GC. Other Ultisols that have a udic moisture regime.

Udults, p. 468

GD. Other Ultisols that have an ustic moisture regime.

Ustults, p. 481

GE. Other Ultisols.

Xerults, p. 489

percent or more *either* of the argillic or kandic horizon if less than 100 cm thick, *or* of its upper 100 cm.

Kanhaplaquults, p. 460

GAF. Other Aquults which:

1. Do not have a lithic, paralithic, or petroferric contact within 150 cm of the mineral soil surface; *and*

2. Within 150 cm of the mineral soil surface, *either*:

a. Do not have a clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content; *or*

b. Have 5 percent or more (by volume) skeletans on faces of peds in the layer that has a 20 percent lower clay content *and*, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction.

Paleaquults, p. 461

GAG. Other Aquults that have an umbric or a mollic epipedon.

Umbraquults, p. 463

GAH. Other Aquults that have episaturation.

Epiaquults, p. 458

GAI. Other Aquults.

Endoaquults, p. 458

Albaquults

Key to subgroups

GACA. Albaquults which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Albaquults

GACB. Other Albaquults that have 50 percent or more chroma of 3 or more in one or more horizons between either the A or Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm.

Aeric Albaquults

GACC. Other Albaquults.

Typic Albaquults

Endoaquults

Key to subgroups

GAIA. Endoaquults that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Endoaquults

GAIB. Other Endoaquults that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Endoaquults

GAIC. Other Endoaquults that have 50 percent or more chroma of 3 or more in one or more horizons between either the A or Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm.

Aeric Endoaquults

GAID. Other Endoaquults.

Typic Endoaquults

Epiaquults

Key to subgroups

GAHA. Epiaquults that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Epiaquults

GAHB. Other Epiaquults that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Epiaquults

GAHC. Other Epiaquults that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Epiaquults

GAHD. Epiaquults that have 50 percent or more chroma of 3 or more in one or more horizons between either the A or Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm.

Aeric Epiaquults

GAHE. Other Epiaquults.

Typic Epiaquults

Fragiaquults

Key to subgroups

GABA. Fragiaquults that have *both*:

1. Fifty percent or more chroma of 3 or more in one or more horizons between either the A or Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and the fragipan; *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthudic Fragiaquults

GABB. Other Fragiaquults that have 50 percent or more chroma of 3 or more in one or more horizons between either the A or Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and the fragipan.

Aeric Fragiaquults

GABC. Other Fragiaquults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Fragiaquults

GABD. Other Fragiaquults that do not have an ochric epipedon.

Umbric Fragiaquults

GABE. Other Fragiaquults.

Typic Fragiaquults

Kandiaquults

Key to subgroups

GADA. Kandiaquults that have an ECEC of 1.5 cmol(+)/kg clay or less (sum of bases extracted with 1N NH_4OAc pH 7, plus 1N-KCl-extractable Al) in one or more horizons within 150 cm of the mineral soil surface.

Acraquoxic Kandiaquults

ULT

GADB. Other Kandiaquults that have *both*:

1. A sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic or a kandic horizon at a depth of 50 to 100 cm; *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Arenic Plinthic Kandiaquults

GADC. Other Kandiaquults which:

1. Do not have an ochric epipedon; *and*

2. Have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic or a kandic horizon at a depth of 50 to 100 cm.

Arenic Umbric Kandiaquults

GADD. Other Kandiaquults that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic or a kandic horizon at a depth of 50 to 100 cm.

Arenic Kandiaquults

GADE. Other Kandiaquults that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic or a kandic horizon at a depth of 100 cm or more.

Grossarenic Kandiaquults

GADF. Other Kandiaquults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Kandiaquults

GADG. Other Kandiaquults that have 50 percent or more chroma of 3 or more in one or more horizons between either the A or Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm.

Aeric Kandiaquults

GADH. Other Kandiaquults that do not have an ochric epipedon.

Umbric Kandiaquults

GADI. Other Kandiaquults.

Typic Kandiaquults

Kanhaplaquults

Key to subgroups

GAEA. Kanhaplaquults that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Arenic Plinthic Paleaquults

GAFC. Other Paleaquults which:

1. Do not have an ochric epipedon; *and*

2. Have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Umbric Paleaquults

GAFD. Other Paleaquults that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Paleaquults

GAFE. Other Paleaquults that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Paleaquults

GAFF. Other Paleaquults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Paleaquults

GAFG. Other Paleaquults that have 50 percent or more chroma of 3 or more in one or more horizons between either the A or Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm.

Aeric Paleaquults

GAFH. Other Paleaquults that do not have an ochric epipedon.

Umbric Paleaquults

GAFI. Other Paleaquults.

Typic Paleaquults

Plinthaquults

Key to subgroups

GAAA. Plinthaquults that have a CEC (by 1N NH_4OAc pH 7) of less than 24 cmol(+)/kg clay[1] in 50 percent or more (by volume) of the argillic horizon if less than 100 cm thick, or of its upper 100 cm.

Kandic Plinthaquults

---

[1] Some soils with properties that approach those of an Oxisol do not disperse well. If the ratio of (percent water retained at 1500 kPa tension minus percent organic carbon) to the percentage of measured clay is 0.6 or more, then the percentage of clay is considered to equal either (1) the measured percentage of clay, or (2) three times (percent water retained at 1500 kPa tension minus percent organic carbon), whichever value is higher, but no more than 100.

GAAB. Other Plinthaquults.

Typic Plinthaquults

Umbraquults

Key to subgroups

GAGA. Umbraquults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Umbraquults

GAGB. Other Umbraquults.

Typic Umbraquults

HUMULTS

Key to great groups

GBA. Humults that have a sombric horizon within 100 cm of the mineral soil surface.

Sombrihumults, p. 468

GBB. Other Humults that have one or more horizons within 150 cm of the mineral soil surface in which plinthite either forms a continuous phase or constitutes one half or more of the volume.

Plinthohumults, p. 468

GBC. Other Humults which:

1. Do not have a lithic, paralithic, or petroferric contact within 150 cm of the mineral soil surface; *and*

2. Have a CEC of 16 cmol(+)/kg clay or less (by 1N NH_4OAc pH 7) and an ECEC of 12 cmol(+)/kg clay or less (sum of bases extracted with 1N NH_4OAc pH 7, plus 1N-KCl-extractable Al) in 50 percent or more *either* of the argillic or kandic horizon if less than 100 cm thick, *or* of its upper 100 cm; *and*

3. Within 150 cm of the mineral soil surface, *either*:

a. Do not have a clay decrease with depth of 20 percent or more (relative) from the maximum clay content; *or*

b. Have 5 percent or more (by volume) skeletans on faces of peds in the layer that has a 20 percent lower clay content *and*, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction.

Kandihumults, p. 465

GBD. Other Humults that have a CEC of 16 cmol(+)/kg clay or less (by 1N NH_4OAc pH 7) and an ECEC of 12 cmol(+)/kg clay or less (sum of bases extracted with 1N

GBFF. Other Haplohumults that have a xeric moisture regime.

Xeric Haplohumults

GBFG. Other Haplohumults.

Typic Haplohumults

Kandihumults

Key to subgroups

GBCA. Kandihumults that have *both*:

1. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *and*

2. In one or more horizons within 75 cm of the mineral soil surface, redox concentrations, a color value, moist, of 4 or more, and a hue which is 10YR or yellower, but which becomes redder with increasing depth within 100 cm of the mineral soil surface.

Andic Ombroaquic Kandihumults

GBCB. Other Kandihumults that have *both*:

1. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *and*

2. An ustic moisture regime.

Ustandic Kandihumults

GBCC. Other Kandihumults that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Kandihumults

GBCD. Other Kandihumults that have, in one or more subhorizons within the upper 25 cm of the argillic or kandic horizon, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Kandihumults

GBCE. Other Kandihumults that have, in one or more horizons within 75 cm of the mineral soil surface, redox concentrations, a color value, moist, of 4 or more, and a hue which is 10YR or yellower, but which becomes redder with increasing depth within 100 cm of the mineral soil surface.

Ombroaquic Kandihumults

GBCF. Other Kandihumults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Kandihumults

GBCG. Other Kandihumults that have an ustic moisture regime.

Ustic Kandihumults

GBCH. Other Kandihumults that have a xeric moisture regime.

Xeric Kandihumults

GBCI. Other Kandihumults that have an anthropic epipedon.

Anthropic Kandihumults

GBCJ. Other Kandihumults.

Typic Kandihumults

Kanhaplohumults

Key to subgroups

GBDA. Kanhaplohumults that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Kanhaplohumults

GBDB. Other Kanhaplohumults that have *both*:

1. An ustic moisture regime; *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Ustandic Kanhaplohumults

GBDC. Other Kanhaplohumults that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Kanhaplohumults

GBDD. Other Kanhaplohumults that have, in one or more subhorizons within the upper 25 cm of the argillic or kandic horizon, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less,

depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

Vertic Hapludults

GCGD. Other Hapludults that have a texture of loamy fine sand or coarser throughout the argillic horizon, or lamellae within its upper 25 cm.

Psammentic Hapludults

GCGE. Other Hapludults that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Hapludults

GCGF. Other Hapludults that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Hapludults

GCGG. Other Hapludults that have, in one or more subhorizons within the upper 60 cm of the argillic horizon, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Hapludults

GCGH. Other Hapludults that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Hapludults

GCGI. Other Hapludults which have either an Ap horizon, or an A horizon 15 cm or more thick, that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample).

Humic Hapludults

GCGJ. Other Hapludults that have an argillic horizon 25 cm or less thick.

Ochreptic Hapludults

GCGK. Other Hapludults.

Typic Hapludults

Kandiudults

Key to subgroups

GCCA. Kandiudults that have:

1. A sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm; *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface; *and*

3. In one or more layers *either* within 75 cm of the mineral soil surface *or*, if the chroma throughout the upper 75 cm results from uncoated sand grains, within the upper 12.5 cm of the argillic or kandic horizon, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Arenic Plinthaquic Kandiudults

GCCB. Other Kandiudults that have *both*:

1. A sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm; *and*

2. In one or more layers *either* within 75 cm of the mineral soil surface *or*, if the chroma throughout the upper 75 cm results from uncoated sand grains, within the upper 12.5 cm of the argillic or kandic horizon, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Arenic Kandiudults

GCCC. Other Kandiudults that have *both*:

1. A sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic or a kandic horizon at a depth of 50 to 100 cm; *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Arenic Plinthic Kandiudults

GCCD. Other Kandiudults that have *both*:

1. A sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic or a kandic horizon at a depth of 50 to 100 cm; *and*

2. Throughout the argillic or kandic horizon, a hue of 2.5YR or redder, a color value, moist, of 3 or less, and a color value, dry, that is no more than one unit higher than the value, moist.

Arenic Rhodic Kandiudults

GCCE. Other Kandiudults that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic or a kandic horizon at a depth of 50 to 100 cm.

Arenic Kandiudults

GCCF. Other Kandiudults that have *both*:

also aquic conditions for some time in most years (or artificial drainage).

Aquandic Kandiudults

GCCL. Other Kandiudults that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Kandiudults

GCCM. Other Kandiudults that have, in one or more layers within 75 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Kandiudults

GCCN. Other Kandiudults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Kandiudults

GCCO. Other Kandiudults that have, in one or more horizons within 75 cm of the mineral soil surface, redox concentrations, a color value, moist, of 4 or more, and a hue which is 10YR or yellower, but which becomes redder with increasing depth within 100 cm of the mineral soil surface.

Ombroaquic Kandiudults

GCCP. Other Kandiudults that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Kandiudults

GCCQ. Other Kandiudults that have a sombric horizon within 150 cm of the mineral soil surface.

Sombric Kandiudults

GCCR. Other Kandiudults that have, throughout the argillic or kandic horizon, a hue of 2.5YR or redder, a color value, moist, of 3 or less, and a color value, dry, that is no more than one unit higher than the value, moist.

Rhodic Kandiudults

GCCS. Other Kandiudults.

Typic Kandiudults

Kanhapludults

ULT

Key to subgroups

GCDA. Kanhapludults that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Kanhapludults

GCDB. Other Kanhapludults that have *both:*

1. A sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic or a kandic horizon at a depth of 50 to 100 cm; *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Arenic Plinthic Kanhapludults

GCDC. Other Kanhapludults that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic or a kandic horizon at a depth of 50 to 100 cm.

Arenic Kanhapludults

GCDD. Other Kanhapludults that have an ECEC of 1.5 cmol(+)/kg clay or less (sum of bases extracted with 1N NH_4OAc pH 7, plus 1N-KCl-extractable Al) in one or more horizons within 150 cm of the mineral soil surface.

Acrudoxic Kanhapludults

GCDE. Other Kanhapludults that have *both:*

1. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface; *and*

2. In one or more layers within 75 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Plinthaquic Kanhapludults

GCDF. Other Kanhapludults that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Kanhapludults

GCDG. Other Kanhapludults that have, in one or more layers within 75 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Kanhapludults

GCDH. Other Kanhapludults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Kanhapludults

3. An ODOE value of 0.12 or more, and a value half as high or lower in an overlying horizon.

Spodic Paleudults

GCEC. Other Paleudults that have *both*:

1. A texture of loamy fine sand or coarser throughout the argillic horizon, or lamellae within its upper 100 cm; *and*

2. In one or more layers *either* within 75 cm of the mineral soil surface *or*, if the chroma throughout the upper 75 cm results from uncoated sand grains, within the upper 12.5 cm of the argillic or kandic horizon, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Psammaquentic Paleudults

GCED. Other Paleudults that have a texture of loamy fine sand or coarser throughout the argillic horizon, or lamellae within its upper 100 cm.

Psammentic Paleudults

GCEE. Other Paleudults that have:

1. In one or more layers *either* within 75 cm of the mineral soil surface *or*, if the chroma throughout the upper 75 cm results from uncoated sand grains, within the upper 12.5 cm of the argillic or kandic horizon, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. A sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm; *and*

3. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Arenic Plinthaquic Paleudults

GCEF. Other Paleudults that have *both*:

1. A sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm; *and*

2. In one or more layers *either* within 75 cm of the mineral soil surface *or*, if the chroma throughout the upper 75 cm results from uncoated sand grains, within the upper 12.5 cm of the argillic or kandic horizon, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and

also aquic conditions for some time in most years (or artificial drainage).

Aquic Arenic Paleudults

GCEG. Other Paleudults that have *both*:

1. A sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm; *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Arenic Plinthic Paleudults

GCEH. Other Paleudults which have *both*:

1. A sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm; *and*

2. Throughout the upper 100 cm of the argillic horizon,

a. A color value, moist, of 3 or less and a color value, dry, that is no more than 1 unit higher than the value, moist; *and*

b. No redox concentrations with a chroma of 3 or more.

Arenic Rhodic Paleudults

GCEI. Other Paleudults that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Paleudults

GCEJ. Other Paleudults that have *both*:

1. A sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more; *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Grossarenic Plinthic Paleudults

GCEK. Other Paleudults that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Paleudults

GCEL. Other Paleudults that have *both*:

1. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface; *and*

b. Have 5 percent or more (by volume) skeletans on faces of peds in the layer that has a 20 percent lower clay content *and*, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction.
Kandiustults, p. 483

GDC. Other Ustults that have a CEC of 16 cmol(+)/kg clay or less (by 1N NH_4OAc pH 7) and an ECEC of 12 cmol(+)/kg clay or less (sum of bases extracted with 1N NH_4OAc pH 7, plus 1N-KCl-extractable Al) in 50 percent or more *either* of the argillic or kandic horizon if less than 100 cm thick, *or* of its upper 100 cm.
Kanhaplustults, p. 486

GDD. Other Ustults which:

1. Do not have a lithic, paralithic, or petroferric contact within 150 cm of the mineral soil surface; *and*

2. Within 150 cm of the mineral soil surface, *either*:

a. Do not have a clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content; *or*

b. Have 5 percent or more (by volume) skeletans on faces of peds in the layer that has a 20 percent lower clay content *and*, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction.
Paleustults, p. 488

GDE. Other Ustults which have *both*:

1. An epipedon that has a color value, moist, of 3 or less throughout; *and*

2. An argillic horizon that has a color value, dry, of 4 or less, and a color value, moist, that is no more than 1 unit lower than the value, dry.
Rhodustults, p. 488

GDF. Other Ustults.
Haplustults, p. 482

Haplustults

Key to subgroups

GDFA. Haplustults that have a lithic contact within 50 cm of the mineral soil surface.
Lithic Haplustults

GDFB. Other Haplustults that have a petroferric contact within 100 cm of the mineral soil surface.
Petroferric Haplustults

GDFC. Other Haplustults that have, in one or more layers both within the upper 12.5 cm of the argillic horizon and within 75 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Haplustults

GDFD. Other Haplustults that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Haplustults

GDFE. Other Haplustults that have, in one or more horizons within 75 cm of the mineral soil surface, redox concentrations, a color value, moist, of 4 or more, and a hue which is 10YR or yellower, but which becomes redder with increasing depth within 100 cm of the mineral soil surface.

Ombroaquic Haplustults

GDFF. Other Haplustults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Haplustults

GDFG. Other Haplustults that have a CEC (by 1N NH_4OAc pH 7) of less than 24 cmol(+)/kg clay[2] in 50 percent or more of the argillic horizon if less than 100 cm thick, or of its upper 100 cm.

Kanhaplic Haplustults

GDFH. Other Haplustults.

Typic Haplustults

Kandiustults

Key to subgroups

GDBA. Kandiustults that have an ECEC of 1.5 cmol(+)/kg clay or less (sum of bases extracted with 1N NH_4OAc pH 7, plus 1N-KCl-extractable Al) in one or more horizons within 150 cm of the mineral soil surface.

Acrustoxic Kandiustults

[2] Some soils with properties that approach those of an Oxisol do not disperse well. If the ratio of (percent water retained at 1500 kPa tension minus percent organic carbon) to the percentage of measured clay is 0.6 or more, then the percentage of clay is considered to equal either (1) the measured percentage of clay, or (2) three times (percent water retained at 1500 kPa tension minus percent organic carbon), whichever value is higher, but no more than 100.

GDBB. Other Kandiustults that have, in one or more layers within 75 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Kandiustults

GDBC. Other Kandiustults that have *both*:

1. A sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic or a kandic horizon at a depth of 50 to 100 cm; *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Arenic Plinthic Kandiustults

GDBD. Other Kandiustults that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic or a kandic horizon at a depth of 50 to 100 cm.

Arenic Kandiustults

GDBE. Other Kandiustults which have *both*:

1. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *and*

2. If neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, and a moisture control section that is dry in some part for 135 or less of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, and a moisture control section that is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Udandic Kandiustults

GDBF. Other Kandiustults that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Kandiustults

GDBG. Other Kandiustults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Kandiustults

GDBH. Other Kandiustults which, if neither irrigated nor fallowed to store moisture, have *either*:

1. A thermic, mesic, or colder soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for more than four tenths of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is moist in some or all parts for less than 180 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Aridic Kandiustults

GDBI. Other Kandiustults which, if neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in some part for 135 cumulative days or less per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Udic Kandiustults

GDBJ. Other Kandiustults that have, throughout the argillic or kandic horizon, a hue of 2.5YR or redder, a color value, moist, of 3 or less, and a color value, dry, that is no more than one unit higher than the value, moist.

Rhodic Kandiustults

GDBK. Other Kandiustults.

Typic Kandiustults

Kanhaplustults

Key to subgroups

GDCA. Kanhaplustults that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Kanhaplustults

GDCB. Other Kanhaplustults that have an ECEC of 1.5 cmol(+)/kg clay or less (sum of bases extracted with 1N NH_4OAc pH 7, plus 1N-KCl-extractable Al) in one or more horizons within 150 cm of the mineral soil surface.

Acrustoxic Kanhaplustults

GDCC. Other Kanhaplustults that have, in one or more layers within 75 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Kanhaplustults

GDCD. Other Kanhaplustults that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic or a kandic horizon at a depth of 50 to 100 cm.

Arenic Kanhaplustults

GDCE. Other Kanhaplustults which have *both*:

1. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *and*

2. If neither irrigated nor fallowed to store moisture, *either*:

    a. A mesic or thermic soil temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in some part for 135 cumulative days or less per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

    b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Udandic Kanhaplustults

GDCF. Other Kanhaplustults that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth

GDCK. Other Kanhaplustults that have, throughout the argillic or kandic horizon, a hue of 2.5YR or redder, a color value, moist, of 3 or less, and a color value, dry, that is no more than one unit higher than the value, moist.

Rhodic Kanhaplustults

GDCL. Other Kanhaplustults.

Typic Kanhaplustults

Paleustults

Paleustults are the Ustults which:

1. Within 150 cm of the mineral soil surface, either:

    a. Do not have a clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content; or

    b. Have 5 percent or more (by volume) skeletans on faces of peds in the layer that has a 20 percent lower clay content and, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction; and

2. Do not have any horizon within 150 cm of the mineral soil surface in which plinthite either forms a continuous phase or constitutes one half or more of the volume; and

3. Do not have a fragipan or kandic horizon.

Plinthustults

Plinthustults are the Ustults that have one or more horizons within 150 cm of the mineral soil surface in which plinthite either forms a continuous phase or constitutes one half or more of the volume.

Rhodustults

Key to subgroups

GDEA. Rhodustults that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Rhodustults

GDEB. Other Rhodustults that have a texture of loamy fine sand or coarser throughout the argillic horizon.

Psammentic Rhodustults

GDEC. Other Rhodustults.

Typic Rhodustults

XERULTS

Key to great groups

GEA. Xerults which:

1. Do not have a lithic or paralithic contact within 150 cm of the mineral soil surface; *and*

2. Within 150 cm of the mineral soil surface, *either*:

a. Do not have a clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content; *or*

b. Have 5 percent or more (by volume) skeletans on faces of peds, or 5 percent or more (by volume) plinthite, or both, in the layer that has a 20 percent lower clay content *and,* below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction.

Palexerults, p.490

GEB. Other Xerults.

Haploxerults, p. 489

Haploxerults

Key to subgroups

GEBA. Haploxerults which have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*

2. In each pedon, a discontinuous argillic horizon that is interrupted by ledges of bedrock.

Lithic Ruptic-Xerochreptic Haploxerults

GEBB. Other Haploxerults that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haploxerults

GEBC. Other Haploxerults that have, in one or more subhorizons within the upper 25 cm of the argillic horizon, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Haploxerults

GEBD. Other Haploxerults that have a texture of loamy fine sand or coarser throughout the argillic horizon, or lamellae within its upper 25 cm.

Psammentic Haploxerults

GEBE. Other Haploxerults that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Haploxerults

GEBF. Other Haploxerults that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Haploxerults

GEBG. Other Haploxerults that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Haploxerults

GEBH. Other Haploxerults.

Typic Haploxerults

Palexerults

Palexerults are the Xerults which:

1. Do not have a lithic or paralithic contact within 150 cm of the mineral soil surface; and

2. Within 150 cm of the mineral soil surface, either:

a. Do not have a clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content; or

b. Have 5 percent or more (by volume) skeletans on faces of peds in the layer that has a 20 percent lower clay content and, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction.

LITERATURE CITED

Sys, C. 1969. The soils of central Africa in the American classification - 7th Approximation, African Soils. XIV:25-44.

Chapter 16

Vertisols[1]

KEY TO SUBORDERS

EA. Vertisols which have, in one or more horizons between 40 and 50 cm from the mineral soil surface, aquic conditions for some time in most years (or artificial drainage) *and one or both* of the following:

1. In more than half of each pedon, either on faces of peds or in the matrix if peds are absent, 50 percent or more chroma of *either*

    a. Two or less if redox concentrations are present; *or*

    b. One or less; *or*

2. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquerts, p. 492

EB. Other Vertisols that have a cryic soil temperature regime.

Cryerts, p. 499

EC. Other Vertisols which, in 6 or more out of 10 years, have *both*:

1. A thermic, mesic, or frigid soil temperature regime; *and*

2. If not irrigated during the year, cracks that remain both:

    a. Five mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 60 or more consecutive days during the 90 days following the summer solstice; *and*

    b. Closed for 60 or more consecutive days during the 90 days following the winter solstice.

Xererts, p. 511

ED. Other Vertisols which, if not irrigated during the year, have cracks in 6 or more out of 10 years that remain closed for less than 60 consecutive days during a period when the soil temperature at a depth of 50 cm from the soil surface is higher than 8°C.

Torrerts, p. 500

---

[1] This chapter on Vertisols was rewritten in 1992 following the recommendations of the International Committee on the Classification of Vertisols (ICOMERT), chaired by Juan Comerma.

EE. Other Vertisols which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 90 or more cumulative days per year.

Usterts, p. 504

EF. Other Vertisols.

Uderts, p. 502

AQUERTS

Key to great groups

EAA. Aquerts which have a salic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Salaquerts, p. 498

EAB. Other Aquerts which have a duripan that has its upper boundary within 100 cm of the mineral soil surface.

Duraquerts, p. 493

EAC. Other Aquerts that have a natric horizon.

Natraquerts, p. 498

EAD. Other Aquerts which have a calcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Calciaquerts, p. 492

EAE. Other Aquerts that have, throughout one or more horizons with a total thickness of 25 cm or more within 50 cm of the mineral soil surface, *both*:

1. An electrical conductivity of the saturation extract of less than 4.0 dS/m at 25°C; *and*

2. A pH value of 4.5 or less in 0.01 M $CaCl_2$ (5.0 or less in 1:1 water).

Dystraquerts, p. 494

EAF. Other Aquerts that have episaturation.

Epiaquerts, p. 496

EAG. Other Aquerts.

Endoaquerts, p. 495

Calciaquerts

Key to subgroups

EADA. Calciaquerts that have, in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 75 cm or the upper boundary of a duripan if shallower, 50 percent or more colors as follows:

1. A hue of 2.5Y or redder and *either*:

    a. A color value, moist, of 6 or more and a chroma of 3 or more; *or*

    b. A color value, moist, of 5 or less and a chroma of 2 or more; *or*

2. A hue of 5Y and a chroma of 3 or more; *or*

3. A chroma of 2 or more, and no redox concentrations.

Aeric Calciaquerts

EADB. Other Calciaquerts.

Typic Calciaquerts

Duraquerts

Key to subgroups

EABA. Duraquerts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 210 or more cumulative days per year.

Aridic Duraquerts

EABB. Other Duraquerts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 90 or more cumulative days per year.

Ustic Duraquerts

EABC. Other Duraquerts that have, in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 75 cm or the upper boundary of the duripan if shallower, 50 percent or more colors as follows:

1. A hue of 2.5Y or redder and *either*:

    a. A color value, moist, of 6 or more and a chroma of 3 or more; *or*

    b. A color value, moist, of 5 or less and a chroma of 2 or more; *or*

2. A hue of 5Y and a chroma of 3 or more; *or*

3. A chroma of 2 or more, and no redox concentrations.

Aeric Duraquerts

EABD. Other Duraquerts that have, in one or more horizons within 30 cm of the mineral soil surface, *one or both* of the following in more than half of each pedon:

EAEG. Other Dystraquerts which have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Dystraquerts

EAEH. Other Dystraquerts that have, in one or more horizons within 30 cm of the mineral soil surface, *one or both* of the following in more than half of each pedon:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more.

Chromic Dystraquerts

EAEI. Other Dystraquerts.

Typic Dystraquerts

Endoaquerts

Key to subgroups

EAGA. Endoaquerts that have, throughout a layer 15 cm or more thick within 100 cm of the mineral soil surface, an electrical conductivity of 15 dS/m or more (1:1 soil:water) for 6 or more months per year in 6 or more out of 10 years.

Halic Endoaquerts

EAGB. Other Endoaquerts that have, in one or more horizons within 100 cm of the mineral soil surface, an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) for 6 or more months per year in 6 or more out of 10 years.

Sodic Endoaquerts

EAGC. Other Endoaquerts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 210 or more cumulative days per year.

Aridic Endoaquerts

EAGD. Other Endoaquerts which have a thermic, mesic, or frigid soil temperature regime and which, if not irrigated during the year, have cracks in 6 or more out of 10 years that remain *both*:

1. Five mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 60 or more consecutive days during the 90 days following the summer solstice; *and*

2. Closed for 60 or more consecutive days during the 90 days following the winter solstice.

Xeric Endoaquerts

EAGE. Other Endoaquerts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or

sodium adsorption ratio of 13 or more) for 6 or more months per year in 6 or more out of 10 years.

Sodic Epiaquerts

EAFC. Other Epiaquerts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 210 or more cumulative days per year.

Aridic Epiaquerts

EAFD. Other Epiaquerts which have a thermic, mesic, or frigid soil temperature regime and which, if not irrigated during the year, have cracks in 6 or more out of 10 years that remain *both*:

1. Five mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 60 or more consecutive days during the 90 days following the summer solstice; *and*

2. Closed for 60 or more consecutive days during the 90 days following the winter solstice.

Xeric Epiaquerts

EAFE. Other Epiaquerts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 90 or more cumulative days per year.

Ustic Epiaquerts

EAFF. Other Epiaquerts that have, in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm, 50 percent or more colors as follows:

1. A hue of 2.5Y or redder and *either*:

   a. A color value, moist, of 6 or more and a chroma of 3 or more; *or*

   b. A color value, moist, of 5 or less and a chroma of 2 or more; *or*

2. A hue of 5Y and a chroma of 3 or more; *or*

3. A chroma of 2 or more, and no redox concentrations.

Aeric Epiaquerts

EAFG. Other Epiaquerts that have a lithic or paralithic contact within 100 cm of the mineral soil surface.

Leptic Epiaquerts

EAFH. Other Epiaquerts which have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Epiaquerts

EAFI. Other Epiaquerts that have, in one or more horizons within 30 cm of the mineral soil surface, *one* *or both* of the following in more than half of each pedon:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more.

Chromic Epiaquerts

EAFJ. Other Epiaquerts.

Typic Epiaquerts

Natraquerts

Key to subgroups

EACA. All Natraquerts.

Typic Natraquerts

Salaquerts

Key to subgroups

EAAA. Salaquerts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 210 or more cumulative days per year.

Aridic Salaquerts

EAAB. Other Salaquerts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 90 or more cumulative days per year.

Ustic Salaquerts

EAAC. Other Salaquerts that have a lithic or paralithic contact within 100 cm of the mineral soil surface.

Leptic Salaquerts

EAAD. Other Salaquerts which have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Salaquerts

EAAE. Other Salaquerts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more; *or*

3. A chroma of 3 or more.

Chromic Salaquerts

EAAF. Other Salaquerts.

Typic Salaquerts

Gypsitorrerts

Key to subgroups

EDBA. Gypsitorrerts that have, in one or more horizons within 30 cm of the soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more; *or*

3. A chroma of 3 or more.

Chromic Gypsitorrerts

EDBB. Other Gypsitorrerts.

Typic Gypsitorrerts

Haplotorrerts

Key to subgroups

EDDA. Haplotorrerts that have, throughout a layer 15 cm or more thick within 100 cm of the soil surface, an electrical conductivity of 15 dS/m or more (1:1 soil:water) for 6 or more months per year in 6 or more out of 10 years.

Halic Haplotorrerts

EDDB. Other Haplotorrerts that have, in one or more horizons within 100 cm of the soil surface, an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) for 6 or more months per year in 6 or more out of 10 years.

Sodic Haplotorrerts

EDDC. Other Haplotorrerts that have a lithic or paralithic contact, or the upper boundary of a duripan, within 100 cm of the soil surface.

Leptic Haplotorrerts

EDDD. Other Haplotorrerts which have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the soil surface.

Entic Haplotorrerts

EDDE. Other Haplotorrerts that have, in one or more horizons within 30 cm of the soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more; *or*

3. A chroma of 3 or more.

Chromic Haplotorrerts

EDDF. Other Haplotorrerts.

Typic Haplotorrerts

aquic conditions for some time in most years (or artificial drainage) *and either*:

1. Redoximorphic features; *or*

2. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquic Hapluderts

EFBC. Other Hapluderts that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Hapluderts

EFBD. Other Hapluderts that have a lithic or paralithic contact within 100 cm of the mineral soil surface.

Leptic Hapluderts

EFBE. Other Hapluderts which have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Hapluderts

EFBF. Other Hapluderts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more; *or*

3. A chroma of 3 or more.

Chromic Hapluderts

EFBG. Other Hapluderts.

Typic Hapluderts

USTERTS

Key to great groups

EEA. Usterts that have, throughout one or more horizons with a total thickness of 25 cm or more within 50 cm of the mineral soil surface, *both*:

1. An electrical conductivity of the saturation extract of less than 4.0 dS/m at 25°C; *and*

2. A pH value of 4.5 or less in 0.01 M $CaCl_2$ (5.0 or less in 1:1 water).

Dystrusterts, **p. 506**

EEB. Other Usterts which have a salic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Salusterts, **p. 510**

EEC. Other Usterts which have a gypsic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Gypsiusterts, p. 507

EED. Other Usterts which have a calcic or petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Calciusterts, p. 505

EEE. Other Usterts.

Haplusterts, p. 508

Calciusterts

Key to subgroups

EEDA. Calciusterts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Calciusterts

EEDB. Other Calciusterts that have, throughout a layer 15 cm or more thick within 100 cm of the mineral soil surface, an electrical conductivity of 15 dS/m or more (1:1 soil:water) for 6 or more months per year in 6 or more out of 10 years.

Halic Calciusterts

EEDC. Other Calciusterts that have, in one or more horizons within 100 cm of the mineral soil surface, an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) for 6 or more months per year in 6 or more out of 10 years.

Sodic Calciusterts

EEDD. Other Calciusterts which have a petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Petrocalcic Calciusterts

EEDE. Other Calciusterts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 210 or more cumulative days per year.

Aridic Calciusterts

EEDF. Other Calciusterts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for less than 150 cumulative days per year.

Udic Calciusterts

EEDG. Other Calciusterts that have a lithic or paralithic contact, or the upper boundary of a duripan, within 100 cm of the mineral soil surface.

Leptic Calciusterts

EEDH. Other Calciusterts which have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Calciusterts

EEDI. Other Calciusterts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more; *or*

3. A chroma of 3 or more.

Chromic Calciusterts

EEDJ. Other Calciusterts.

Typic Calciusterts

Dystrusterts

Key to subgroups

EEAA. Dystrusterts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Dystrusterts

EEAB. Other Dystrusterts that have, in one or more horizons within 100 cm of the mineral soil surface, aquic conditions for some time in most years (or artificial drainage) *and either*:

1. Redoximorphic features; *or*

2. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquic Dystrusterts

EEAC. Other Dystrusterts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 210 or more cumulative days per year.

Aridic Dystrusterts

EEAD. Other Dystrusterts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for less than 150 cumulative days.

Udic Dystrusterts

EEAE. Other Dystrusterts that have a lithic or paralithic contact, or the upper boundary of a duripan, within 100 cm of the mineral soil surface.

Leptic Dystrusterts

EEAF. Other Dystrusterts which have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Dystrusterts

EEAG. Other Dystrusterts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more; *or*

3. A chroma of 3 or more.

Chromic Dystrusterts

EEAH. Other Dystrusterts.

Typic Dystrusterts

Gypsiusterts

Key to subgroups

EECA. Gypsiusterts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Gypsiusterts

EECB. Other Gypsiusterts that have, throughout a layer 15 cm or more thick within 100 cm of the mineral soil surface, an electrical conductivity of 15 dS/m or more (1:1 soil:water) for 6 or more months per year in 6 or more out of 10 years.

Halic Gypsiusterts

EECC. Other Gypsiusterts that have, in one or more horizons within 100 cm of the mineral soil surface, an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) for 6 or more months per year in 6 or more out of 10 years.

Sodic Gypsiusterts

EECD. Other Gypsiusterts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 210 or more cumulative days per year.

Aridic Gypsiusterts

EECE. Other Gypsiusterts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for less than 150 cumulative days per year.

Udic Gypsiusterts

EECF. Other Gypsiusterts that have a lithic or paralithic contact, or the upper boundary of a duripan or petrocalcic horizon, within 100 cm of the mineral soil surface.

Leptic Gypsiusterts

EECG. Other Gypsiusterts which have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Gypsiusterts

EECH. Other Gypsiusterts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more; *or*

3. A chroma of 3 or more.

Chromic Gypsiusterts

EECI. Other Gypsiusterts.

Typic Gypsiusterts

Haplusterts

<u>Key to subgroups</u>

EEEA. Haplusterts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haplusterts

EEEB. Other Haplusterts that have, throughout a layer 15 cm or more thick within 100 cm of the mineral soil surface, an electrical conductivity of 15 dS/m or more (1:1 soil:water) for 6 or more months per year in 6 or more out of 10 years.

Halic Haplusterts

EEEC. Other Haplusterts that have, in one or more horizons within 100 cm of the mineral soil surface, an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) for 6 or more months per year in 6 or more out of 10 years.

Sodic Haplusterts

EEED. Other Haplusterts which have a petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Petrocalcic Haplusterts

EEEE. Other Haplusterts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 210 or more cumulative days per year.

Aridic Haplusterts

EEEF. Other Haplusterts which have *both*:

1. A lithic or paralithic contact within 100 cm of the mineral soil surface; *and*

2. If not irrigated during the year, cracks in 6 or

s t f 10 en th t 5 'd

EEEG. Other Haplusterts which have *both*:

1. A layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface; *and*

2. If not irrigated during the year, cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for less than 150 cumulative days per year.

Entic Udic Haplusterts

EEEH. Other Haplusterts which have *both*:

1. In one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

a. A color value, moist, of 4 or more; *or*

b. A color value, dry, of 6 or more; *or*

c. A chroma of 3 or more; *and*

2. If not irrigated during the year, cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for less than 150 cumulative days per year.

Chromic Udic Haplusterts

EEEI. Other Haplusterts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for less than 150 cumulative days per year.

Udic Haplusterts

EEEJ. Other Haplusterts that have a lithic or paralithic contact, or the upper boundary of a duripan, within 100 cm of the mineral soil surface.

Leptic Haplusterts

EEEK. Other Haplusterts which have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Haplusterts

EEEL. Other Haplusterts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more; *or*

3. A chroma of 3 or more.

Chromic Haplusterts

EEEM. Other Haplusterts.

Typic Haplusterts

Salusterts

Key to subgroups

EEBA. Salusterts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Salusterts

EEBB. Other Salusterts that have, in one or more horizons within 100 cm of the mineral soil surface, an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) for 6 or more months per year in 6 or more out of 10 years.

Sodic Salusterts

EEBC. Other Salusterts that have, in one or more horizons within 100 cm of the mineral soil surface, aquic conditions for some time in most years (or artificial drainage) *and either*:

1. Redoximorphic features; *or*

2. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquic Salusterts

EEBD. Other Salusterts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 210 or more cumulative days per year.

Aridic Salusterts

EEBE. Other Salusterts that have a lithic or paralithic contact, or the upper boundary of a duripan or petrocalcic horizon, within 100 cm of the mineral soil surface.

Leptic Salusterts

EEBF. Other Salusterts which have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Salusterts

EEBG. Other Salusterts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more; *or*

3. A chroma of 3 or more.

Chromic Salusterts

EEBH. Other Salusterts.

Typic Salusterts

XERERTS

Key to great groups

ECA. Xererts which have a duripan that has its upper boundary within 100 cm of the mineral soil surface.

Durixererts, p. 512

ECB. Other Xererts which have a calcic or petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Calcixererts, p. 511

ECC. Other Xererts.

Haploxererts, p. 513

Calcixererts

Key to subgroups

ECBA. Calcixererts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Calcixererts

ECBB. Other Calcixererts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that remain 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 180 or more consecutive days.

Aridic Calcixererts

ECBC. Other Calcixererts which have a petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Petrocalcic Calcixererts

ECBD. Other Calcixererts that have a lithic or paralithic contact within 100 cm of the mineral soil surface.

Leptic Calcixererts

ECBE. Other Calcixererts which have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Calcixererts

ECBF. Other Calcixererts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*
2. A color value, dry, of 6 or more; *or*
3. A chroma of 3 or more.

Chromic Calcixererts

ECBG. Other Calcixererts.

Typic Calcixererts

Haploxererts

Key to subgroups

ECCA. Haploxererts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haploxererts

ECCB. Other Haploxererts that have, throughout a layer 15 cm or more thick within 100 cm of the mineral soil surface, an electrical conductivity of 15 dS/m or more (1:1 soil:water) for 6 or more months per year in 6 or more out of 10 years.

Halic Haploxererts

ECCC. Other Haploxererts that have, in one or more horizons within 100 cm of the mineral soil surface, an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) for 6 or more months per year in 6 or more out of 10 years.

Sodic Haploxererts

ECCD. Other Haploxererts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that remain 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 180 or more consecutive days.

Aridic Haploxererts

ECCE. Other Haploxererts that have, in one or more horizons within 100 cm of the mineral soil surface, aquic conditions for some time in most years (or artificial drainage) *and either*

1. Redoximorphic features; *or*

2. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

Aquic Haploxererts

ECCF. Other Haploxererts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that remain 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for less than 90 consecutive days.

Udic Haploxererts

ECCG. Other Haploxererts that have a lithic or paralithic contact within 100 cm of the mineral soil surface.

Leptic Haploxererts

ECCH. Other Haploxererts which have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Haploxererts

ECCI. Other Haploxererts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more; *or*

3. A chroma of 3 or more.

Chromic Haploxererts

ECCJ. Other Haploxererts.

Typic Haploxererts

Designations for Horizons and Layers

Genetic soil horizons are not the equivalent of the diagnostic horizons of *Soil Taxonomy*. While designations of genetic horizons express a qualitative judgment about the kinds of changes that are believed to have taken place in a soil, diagnostic horizons are quantitatively defined features which are used to differentiate between taxa. A diagnostic horizon may encompass several genetic horizons, and changes implied by genetic horizon designations may not be large enough to justify recognizing different diagnostic horizons. Genetic horizons are designated as follows.

MASTER HORIZONS AND LAYERS

The capital letters O, A, E, B, C, and R represent the master horizons and layers of soils. These capital letters are the base symbols to which other characters are added to complete the designations. Most horizons and layers are given a single capital-letter symbol; some require two.

O horizons or layers: *Layers dominated by organic material. Some are saturated with water for long periods, or were once saturated but are now artificially drained; others have never been saturated.*

Some O layers consist of undecomposed or partially decomposed litter (such as leaves, needles, twigs, moss, and lichens) that has been deposited on the surface; they may be on top of either mineral or organic soils. Other O layers consist of organic material that was deposited under saturated conditions and has decomposed to varying stages. The mineral fraction of such material constitutes only a small percentage of its volume and generally much less than half of its weight. Some soils consist entirely of materials designated as O horizons or layers.

An O layer may be on the surface of a mineral soil, or at any depth below the surface if it is buried. A horizon formed by the illuviation of organic material into a mineral subsoil is not an O horizon, although some horizons that have formed in this manner contain considerable amounts of organic matter.

A horizons: *Mineral horizons which have formed at the surface or below an O horizon; they exhibit obliteration of all or much of the original rock structure*[1] *and show one or both of the following*: (1) *an accumulation of humified organic matter intimately mixed with the*

---

[1] Rock structure includes fine stratification in unconsolidated soil materials as well as pseudomorphs of weathered minerals that retain their positions relative to each other and to unweathered minerals in saprolite.

mineral fraction and not dominated by properties characteristic of E or B horizons (defined below), or (2) *properties resulting from cultivation, pasturing, or similar kinds of disturbance.*

If a surface horizon has properties of both A and E horizons but the feature emphasized is an accumulation of humified organic matter, it is designated an A horizon. In some places, as in warm arid climates, the undisturbed surface horizon is less dark than the adjacent underlying horizon and contains only small amounts of organic matter; it has a morphology distinct from the C layer, although the mineral fraction is unaltered or only slightly altered by weathering. Such a horizon is designated A because it is at the surface; however, recent alluvial or eolian deposits that retain fine stratification are not considered to be A horizons unless cultivated.

E horizons: *Mineral horizons in which the main feature is loss of silicate clay, iron, or aluminum, or some combination of these, leaving a concentration of sand and silt particles. These horizons exhibit obliteration of all or much of the original rock structure*[2].

An E horizon is most commonly differentiated from an underlying B horizon in the same sequum by a color of higher value or lower chroma or both, by coarser texture, or by a combination of these properties. In some soils the color of the E horizon is that of the sand and silt particles, but in many soils coatings of iron oxides or other compounds mask the color of the primary particles. An E horizon is most commonly differentiated from an overlying A horizon by its lighter color. It generally contains less organic matter than the A horizon. An E horizon is commonly near the surface below an O or A horizon and above a B horizon, but the symbol E can be used for eluvial horizons which are within or between parts of the B horizon, or which extend to depths greater than normal observation if the horizon is pedogenic.

B horizons: *Horizons which have formed below an A, E, or O horizon; they are dominated by the obliteration of all or much of the original rock structure and show one or more of the following:*

(1) *Illuvial concentration of silicate clay, iron, aluminum, humus, carbonates, gypsum, or silica, alone or in combination;*

(2) *Evidence of removal of carbonates;*

(3) *Residual concentration of sesquioxides;*

(4) *Coatings of sesquioxides that make the horizon conspicuously lower in color value, higher in chroma, or redder in hue, without*

---

[2] See footnote 1.

apparent illuviation of iron, than overlying and underlying horizons;

(5) *Alteration which forms silicate clay or liberates oxides, or both, and which forms a granular, blocky, or prismatic structure if volume changes accompany changes in moisture content*; *or*

(6) *Brittleness*.

All the different kinds of B horizons are, or were originally, subsurface horizons. Included as B horizons, where contiguous to other genetic horizons, are layers of illuvial concentration of carbonates, gypsum, or silica which are the result of pedogenic processes (and may or may not be cemented), and brittle layers that show other evidence of alteration, such as prismatic structure or illuvial accumulation of clay.

Examples of layers that are not B horizons are: layers in which clay films either coat rock fragments or cover finely stratified unconsolidated sediments, regardless of whether the films were formed in place or by illuviation; layers into which carbonates have been illuviated but which are not contiguous to an overlying genetic horizon; and layers with gleying but no other pedogenic changes.

C horizons or layers: *Horizons or layers, excluding hard bedrock, that are little affected by pedogenic processes and lack the properties of O, A, E, or B horizons. Most are mineral layers. The material of C layers may be either like or unlike the material from which the solum has presumably formed. The C horizon may have been modified, even if there is no evidence of pedogenesis.*

Included as C layers are sediment, saprolite, unconsolidated bedrock, and other geologic materials which are commonly uncemented and characterized by low or moderate excavation difficulty. Some soils form in material that is already highly weathered, and if such material does not meet the requirements for A, E, or B horizons, it is designated C. Changes not considered pedogenic are those not related to overlying horizons. Layers that contain accumulations of silica, carbonates, gypsum, or more soluble salts are included in C horizons, even if indurated. However, if an indurated layer is obviously affected by pedogenic processes, it is considered a B horizon.

R layers: *Hard Bedrock*

Granite, basalt, quartzite, and indurated limestone or sandstone are examples of bedrock designated R. R layers are cemented, and excavation difficulty exceeds moderate. The R layer is sufficiently coherent when moist to make hand-digging with a spade impractical, although it may be chipped or scraped. Some R layers can be ripped with heavy power equipment. The bedrock may contain cracks, but these are generally too few and too small to allow roots to penetrate. The cracks may be coated or filled with clay or other material.

Transitional and combination horizons

Horizons dominated by properties of one master horizon but having subordinate properties of another: Two capital-letter symbols are used for such transitional horizons, e.g., AB, EB, BE, or BC. The first of these symbols indicates that the properties of the horizon so designated dominate the transitional horizon. An AB horizon, for example, has characteristics of both an overlying A horizon and an underlying B horizon, but it is more like the A than like the B.

In some cases, a horizon can be designated as transitional even if one of the master horizons to which it presumably forms a transition is not present. A BE horizon may be recognized in a truncated soil if its properties are similar to those of a BE horizon in a soil from which the overlying E horizon has not been removed by erosion. A BC horizon may be recognized even if no underlying C horizon is present; it is transitional to assumed parent materials.

Horizons with two distinct parts that have recognizable properties of the two kinds of master horizons indicated by the capital letters: The two capital letters designating such combination horizons are separated by a virgule (/), e.g., E/B, B/E, or B/C. Most of the individual parts of one horizon component are surrounded by the other.

The designation may be used even when horizons similar to one or both of the components are not present, provided that the separate components can be recognized in the combination horizon. The first symbol is that of the horizon with the greater volume.

Single sets of horizon designators do not cover all situations; therefore, some improvising has to be done. For example, Alfic Udipsamments have lamellae that are separated from each other by eluvial layers. Because it is generally not practical to describe each lamella and eluvial layer as a separate horizon, the horizons can be combined but the components described separately. One horizon then contains several lamellae and eluvial layers and can be designated an "E and Bt" horizon. The complete horizon sequence for this soil could be: Ap-Bw-E and Bt1-E and Bt2-C.

SUBORDINATE DISTINCTIONS WITHIN MASTER HORIZONS AND LAYERS

Lower-case letters are used as suffixes to designate specific kinds of master horizons and layers. The term

is lithologically unlike the overlying material, the discontinuity is indicated by a number prefix, and the symbol for the buried horizon is used in addition, e.g.: Ap-Bt1-Bt2-BC-C-2ABb-2Btb1-2Btb2-2C.

In organic soils, discontinuities between different kinds of layers are not identified. In most cases such differences are identified either by letter-suffix designations if the different layers are organic, or by the master symbol if the different layers are mineral.

USE OF THE PRIME

If a pedon contains two or more horizons of the same kind which are separated by one or more horizons of a different kind, identical letter and number symbols can be used for those horizons that have the same characteristics. For example, the sequence A-E-Bt-E-Btx-C identifies a soil that has two E horizons. To emphasize this characteristic, the prime (the symbol ') is added after the master-horizon symbol of the lower of the two horizons that have identical designations, e.g.: A-E-Bt-E'-Btx-C. The prime, when appropriate, is applied to the capital-letter horizon designation, and any lower-case letter symbols follow it: B't. It is used only when the letter designations of the two layers in question are completely identical. In the rare cases when three layers have identical letter symbols, a double prime can be used for the lowest of these layers: E".

The same principle applies in designating layers of organic soils. The prime is used only to distinguish two or more horizons that have identical symbols; e.g., Oi-C-O'i-C' when the soil has two identical Oi layers, or Oi-C-Oe-C' when the two C layers are of the same kind.

SI Unit Conversion Table

CEC and ECEC:

1 meq/100 g soil = 1 cmol(+)/kg soil

Conductivity:

1mmho/cm = 1 dS/m

Pressure:

15-bar water = 1500 kPa water retention

1/3-bar water = 33 kPa water retention

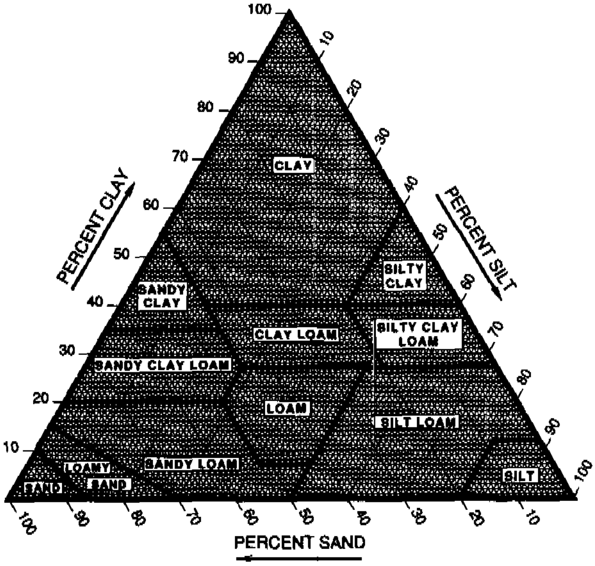

Chart showing the percentages of clay (below 0.002 mm), silt (0.002 to 0.05 mm), and sand (0.05 to 2.0 mm) in the basic soil textural classes.

INDEX

A

B

G

H

I

J-K

L

M

N

T

U

V

W-X-Y-Z